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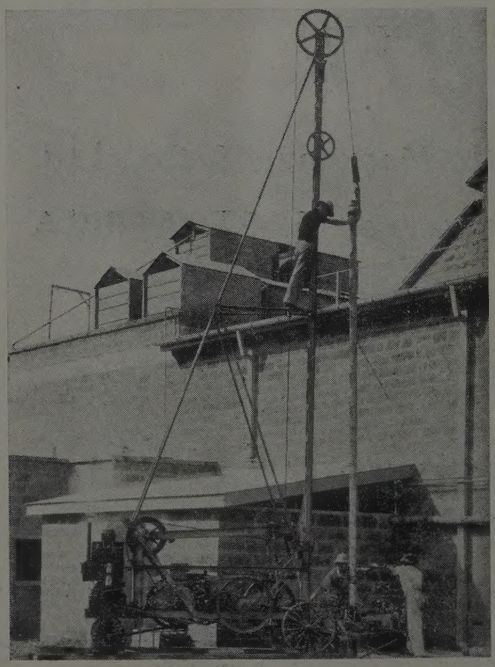

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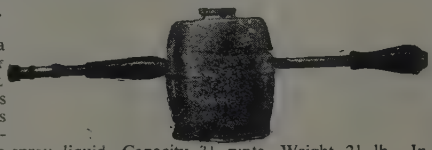

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THE EAST AFRICAN AGRICULTURAL JOURNAL

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FOREWORD

Grass is of essential importance in a balanced farming system and, on a wider outlook still, to hold the soil. By consequence, as Mr. Edwards showed in the last number of this Journal, grass and grassland research, to the necessity of which we have so belatedly awakened, takes diverse forms; primarily it must explore the possibilities of establishing and maintaining such grass cover as will stop erosion and at the same time it must find grasses and work out plans of grassland management to satisfy the needs of the stock-owner. Contributions to these problems are a special feature of this number. Mr. Edwards describes Perennial Kavirondo Sorghum, a high-yielding fodder-grass, markedly drought-resistant, seed supplies of which have been obtained by multiplication from a single wild plant spotted in the field. Its use as a temporary grazing ley in rotation with cash and food crops should be of great value in dry areas. A second contribution by Mr. Edwards describes the success obtained in the experimental establishment of grass under maize. The object was to avoid that period in ordinary maize farming when the absence of plant-roots from the soil favours the deterioration of soil-structure that is as subtle and insidious as it is disastrous. With practically no reduction in maize yield, it was found possible to overlap the maize crop with a pasture ley, an operation that seems likely to be achieved in all favourable seasons.

Messrs. Hosking and Stephens' paper is concerned also with the establishment of a satisfactory grazing ley under the conditions of Teso, Uganda. Unexpected complications occurred owing to the selective grazing by the cattle.

In this connexion the brief reprint under the heading "Dangerous Grass" is a timely reminder from America that when you have got grass to grow on a piece of abandoned land you have not necessarily turned it into a grazing proposition. The soil may be so deficient in the mineral nutrients necessary for healthy animal life that stock could not thrive upon it. There are indeed grasslands on Africa's ancient maltreated land-surface upon which stock confined without extensive supplementary feeding would shortly die.

The composition of African foodstuffs is, as Dr. French shows in his interesting article, not necessarily the reason why cattle with a high proportion of European blood do so badly in hot climates. A major reason is that their physiology, their shape and their bulk all combine to make it more difficult for them to keep their body-temperature down as tropical breeds can do. The immediate result is that they spend a large part of the twenty-four hours in a state of mild fever, with the concomitant ill-effects most of us know from painful personal experience.

Following this foreword we print a plea for simplicity in presenting facts and drawing conclusions. Readers may think it is not so much a plea as a broadside. In a still small voice we second it. Great harm is done by hiding facts in a fog of words, figures or, worst of all, symbols. We know a prominent scientific man who has worked in Africa for many years and written many scientific papers, by no means to be dismissed as unimportant, but his presentation of essentially simple facts has become so recondite that students even in his own line of work often cannot be bothered to try and follow his arguments. For such articles as this Journal publishes it is certainly of first

importance that wording should be simple and that the use of technical terms (and words from tribal languages) should be reduced to the minimum necessary for precision. But for an article to command full attention liveliness and directness are also necessary. The writing of Sir George Stapledon is a good modern example. Erudition is not incompatible with "punch".

LET'S BE SIMPLE

A number of scientific papers dealing with a vital problem in East Africa have recently come my way, and I know their author hopes others will use his results and apply his conclusions. But they won't—of that there is no doubt—simply because no one who is not a combination of an expert riddle-solver and a calculating machine can possibly understand what he writes. Yet what he has to say is really quite easy to understand, and would go right home if only he would stop saying the simplest things in the profoundest language and muddling his readers with masses of quite unnecessary mathematics.

"The degree of human contiguity, C, is significantly and positively correlated with the contentment index, C^1, of the population in question ($r_{\infty_1} = + .9999 \pm .00001$; $P < .002$)" may mean to some, "The more we are together the happier we shall be," but it certainly doesn't to most; so why say it like that if you want people to understand? Yet that is the sort of thing we constantly have to read, and it is small wonder that so little comes of it.

Statistics are being used (and abused) more and more by people who seem to forget that although they are a useful tool they are a dashed confusing toy, especially in the hands of those scientific children who have only just come by their new plaything and frequently forget that what comes out of the mathematical machine can in no wise mean more than what goes into it.

It is like making sausages. If bad meat goes in, it is still bad when it comes out; if there is too little of it, you won't get all the sausages you hoped for. And so it is with any mathematical process. If you put in dud data, your final answer will be dud, even if it *is* clothed in a lovely intellectual-looking sausage skin decorated with symbols borrowed from the Greek alphabet.

The object of any scientific writing is, or should be, to explain things to others. If you do that you succeed, and the best way of doing it is not to strive after erudition nor to aim at impressing the world with what you know (or think you know), but merely to state the facts as simply as you can. The work will be all the sounder for it. It is simply amazing how much rot passes muster when clothed in verbiage.

The other day I set about paraphrasing a very involved paper on nutrition. The effect was startling. Half of it proved to be purely platitudinous, and I found myself writing such pearls of wisdom as, "The more food they get the less hungry they are." Is it really worth while printing stuff like that at any time, let alone when paper is precious?

At the other end of the scale there are men, acknowledged experts in various branches of science, who write so delightfully simply that even those who know scarcely anything about the subject can understand their works. They are the sort of scientific writers we need in East Africa, the only sort whose work will be applied. Let's have more of their kind. Let's be simple.

A. T. CULWICK.

A NOTE ON THE MANURING OF DERRIS

In an observational trial, adjacent beds of about 400 plants in a plot of Derris at Kwamkoro, near Amani, were treated individually with dung, compost, lime and superphosphates, one dressing being given immediately prior to planting.

The roots were harvested when three years old. None of the treatments gave any very large increase in yield over the untreated controls, but suggestions of a response to some of the treatments are now being examined in a replicated plot experiment.

Potash and nitrogen were not included, as sand culture experiments have indicated that only very small amounts are needed in the soil for normal growth of Derris.

R.R.W.

A NEW FODDER CROP: PERENNIAL KAVIRONDO SORGHUM

By D. C. Edwards, B.Sc., Senior Agricultural Officer (Pasture Research), Department of Agriculture, Kenya

(*Received for publication 21st January*, 1941)

Where attempts have been made to employ more intensive methods of land utilization than the uncontrolled grazing of low-producing animals, practised by the roving pastoral tribes, the storage of fodder as a reserve for the dry periods of the year has become an essential factor in the pasture management of all parts of East Africa. Even in the semi-arid areas, now largely occupied by these tribes, it would appear that conservation of fodder may play a part in future development. This fact has been recognized from the outset of the work on pasture improvement, and in Kenya a parallel line of investigation has been a search for highly productive crops which can be used both for feeding in the green state and for storing as silage. As in the case of pasture plants, main attention has been paid to the indigenous flora and to crops which are already used for feeding animals under native farming conditions. Types for the production of fodder in the moister areas of the country present little difficulty, as there is a considerable range of crops from which to choose. It is at the drier fringe of the mixed farming area where most difficulty arises in both European and native districts, and it is here that the greatest need for fodder storage exists. Frequently in this region conditions are too dry for the production of maize silage, and attention has been turned for some years past to varieties of sorghum. Sudan grass (*Sorghum sudanense* Stapf) has been used to some extent by European farmers, and fairly extensive trials of American sorghum varieties have been made in both European and native areas, with little success. It is noteworthy that in this work no attention appears to have been paid hitherto to the possibilities of the sorghum types which are widely used in the native agriculture of East Africa for grain production, although these are obviously much better adapted to the climatic conditions than any of the varieties so far introduced from other countries.

In May, 1935, the seed of a single plant, of a type very similar in appearance to Sudan grass, was obtained from near Maseno in the Kavirondo area of Kenya, and the work reported below has been carried out on the progeny derived from this seed. The material was first increased in a nursery, and specimens were sent to the Royal Botanic Gardens at Kew for identification. The authorities at Kew suggested that the material resulted from a natural hybrid between a native cultivated grain sorghum and *Sorghum verticilliflorum* Stapf, a widely distributed wild sorghum of Kenya.

The initial trials showed that the plant is a perennial of considerable duration (plants five years old exhibit no obvious diminution in yield), that a heavy seed crop is produced, and that establishment from seed is exceptionally easy.

In 1939 an issue of 10 lb. of seed was made for trial in the Ukamba native area, where the rainfall of 25 to 30 inches is distinctly erratic. It happened that this year was one of exceptionally severe drought, and the crop showed remarkable possibilities under low rainfall. Also in June of the same year a preliminary feeding trial of the Perennial Kavirondo Sorghum was carried out. Two bullocks were fed on the cut green material at flowering stage for a period of three days. On each of the first two days of the experiment, 60 lb. was consumed, and 40 lb. on the third day. The animals relished the sorghum and no ill-effects were observed.

Having built up a considerable supply of seed, the next step was to determine the yield of green material for silage production under field conditions, and also to test the qualities of the aftermath as pasturage. Accordingly, in April, 1940, a plot of slightly less than two-thirds of an acre was established from seed at Kabete. The crop was sown in drills 2 ft. apart and seed was used at the rate of 20 lb. per acre. In order to determine the yield of green matter, three quadrats, each of one-hundredth of an acre, were demarcated at random within the plot. These areas were cut and the yields weighed on the 26th August, when the sorghum was at the flowering stage, but before the seed had matured, with the following results:—

TABLE I

YIELD OF GREEN MATERIAL FROM THE PERENNIAL KAVIRONDO SORGHUM 18 WEEKS FROM SOWING

1/100 Acre Quadrat	Yield in Lb.
1	325·75
2	355·50
3	377·25

Average yield per 1/100 acre = 352·83 lb.
Yield per acre .. .. .. = 15·75 tons

In the same experimental area, the yield of maize for fodder has varied over a number of years from 11 to 23 tons per acre. In the season when the above results were obtained, nearby plots of maize gave 19.8 tons per acre of green matter.

At the time of making the above yield determination, composite samples representative of all three quadrats were taken for chemical analysis. Table II gives the chemical composition of the Perennial Kavirondo Sorghum with figures for Sudan grass at a similar stage of growth, from an American source (Morrison, *Feeds and Feeding*), for purposes of comparison.

TABLE II

CHEMICAL COMPOSITION OF CROP IN BLOOM AND IN CONDITION FOR SILAGE. BASED ON AIR-DRY MATERIAL

	Perennial Kavirondo Sorghum	Sudan Grass
Moisture ..	6·3	10·8
Crude protein ..	7·4	8·4
Fat	1·3	1·5
Crude fibre ..	34·5	30·7
Carbohydrates ..	44·5	41·7
Mineral matter ..	6·0	6·8

Following the determination of yield for silage production, the remainder of the plot was allowed to mature seed, which was harvested in September and October. The seed obtained was 199 lb., and the yield per acre is estimated to be approximately 350 lb.

Aftermath pasturage

An important feature of the Perennial Kavirondo Sorghum is its perennial habit, which appears to give it a distinct advantage over Sudan grass, and extends the possibility of its use in mixed farming, not only as a highly productive fodder crop, but also as a temporary ley for grazing purposes. In this connexion it is necessary to show that the crop is not prone to develop cyanogenetic properties, of which all the sorghum types are held suspect. A trial of aftermath grazing was therefore made under conditions which appeared most likely to bring out any toxic properties.

The crop was cut on the 28th October at the completion of the seed harvest. Sufficient rain fell during November to produce vigorous growth; conditions then rapidly became dry and there was a check in the growth. Five 2½-year-old heifers were turned on to the plot on the 9th December and were confined to the plot until the 19th of the month, a period of ten days. A trough of water was provided and, with the exception of the lick of common salt usually supplied at Kabete, the animals fed entirely upon the sorghum for the above period. At the commencement of grazing there was a lush growth of aftermath a foot to eighteen inches in height. The animals took a little time to become accustomed to the herbage, but after the first day they fed considerably in the early morning, and then grazed contentedly for the remainder of the day. Throughout the period of the experiment climatic conditions appeared ideal for the development of cyanogenetic properties. In the mornings the herbage was frequently moist, while most of the days were hot with bright sun and a light breeze. From the fifth day onwards there was a general appearance of slight wilting of the sorghum leafage in the plot, due to the atmospheric conditions and trampling by the animals. Although it was anticipated that the lush growth of herbage, often with surface moisture in the early mornings, might cause "hoven" (tympanitis), no difficulty was experienced from this cause. At the end of the experiment the animals were in good condition. No significant changes in weight were expected over such a short period, but three had gained slightly and two lost slightly.

As to the amount of grazing available, no attempt was made to determine this accurately. After ten days the plot was somewhat fouled, and at least half the herbage remained unconsumed. It is estmimated that the crop provided a total of approximately 155 cattle-days grazing of twenty-four hours each per acre.

The above experiment indicates that the development of toxic properties in the Perennial Kavirondo Sorghum is, to say the least, extremely improbable, and that this remote possibility need not stand in the way of its extensive use. In order further to test this possibility, however, a trial in which the dice was definitely loaded against the animal was

carried out at the Veterinary Research Laboratory. A quantity of cut young leafage was placed in an incubator at a temperature of 36° C. for a period of twenty-four hours. This material was then fed to a cow and an eighteen-months-old calf over a period of twenty-four hours, the animals having received no food for a day and night prior to the test. A considerable quantity of the sorghum was consumed, with no ill-effect.

Discussion

It is believed that in the Perennial Kavirondo Sorghum a fodder crop has been discovered which will go far to fulfil a requirement of long standing in the drier mixed farming areas of East Africa, both native and European. Hitherto, no satisfactory perennial crop has been available, and maize is not dependable in these areas. This sorghum has the advantage over many of the common fodder crops that it is very easily established from seed. During investigations which have been carried out over several years, germination has always been near to 100 per cent. The seedlings develop rapidly and the crop is capable of establishing itself under moisture conditions which would inhibit the establishment of most fodder-producing plants. A heavy crop of green material for silage production is obtained in from 14 to 18 weeks from sowing. Furthermore, the advantage afforded by the perennial habit of this sorghum appears to go further than obviating the necessity of cultivation and re-sowing annually as in the case of Sudan grass and certain other crops. It holds forth the possibility of combining fodder production and a temporary grazing ley in the same crop; a distinct advantage in areas where the artificial establishment of grass is uncertain and where a primary aim must be the storage of fodder. To such areas, under an erratic rainfall of 20 to 30 inches per annum, the Perennial Kavirondo Sorghum appears to be well suited and, in Kenya, a silage crop with aftermath grazing can be expected with both the long and the short rains each year.

In order to visualize more clearly how this new crop is expected to fit into farming practice it may be well to consider actual examples. There is the case of the European farmer in a part of Kenya which has a rainfall of about 25 inches per annum. He may be interested mainly in dairy farming and may grow, in addition, such a cash crop as wheat. His herd will be dependent upon natural pasture for grazing, and the maintenance of a reserve supply of fodder in the form of silage for use in the dry periods of the year will be an imperative necessity. In such a case it appears that the Perennial Kavirondo Sorghum may well provide the means of maintaining the fertility of the wheat lands by its use as a temporary ley and, at the same time, act as the main source of stored fodder. The rotation of the sorghum area over the wheat lands should afford the benefit of concentrating animals over the whole wheat area in turn and also provide valuable dry-season pasturage. In the native holding under similar climatic conditions it may serve as a means of relieving the land from the detrimental effects of the constant working and exposure of the soil which accompany cash and food crop production, while also assisting towards a more intimate relationship between the grazing animal and arable crop cultivation. The fact that the Perennial Kavirondo Sorghum is, in addition, capable of producing a food crop of grain which, although apparently not of high palatability, may serve as an emergency supply for drought years, makes it so much the more acceptable to the native cultivator.

It has already been mentioned that the suggestion has been made that this sorghum is the result of a cross between a native cultivated grain sorghum and the common indigenous *Sorghum verticilliflorum* of Kenya. Evidence in support of the suggestion has been afforded by the first large-scale sowing of the plant which was made at Kabete in April, 1940. Several types were prominent in the crop, and the two most distinct of these are illustrated by the photographs, Figs. 1 and 2. The "Black Type," which has an open panicle and shining black fruits at maturity, constitutes the bulk of the crop, while the "*Mtama*-like Type" has a comparatively short, compact inflorescence and fruits which are less flattened than those of the previous type; in general appearance it is similar to the grain sorghum, *mtama* (probably a variety of *S. vulgare* Pers.), which is widely used in native agriculture. There is evidently scope for selection in this crop, and steps have already been taken to harvest separately the seed of different types, but it is not suggested that the use of the crop in practice need await further development in this direction.

It is stated above that the original material of the Perennial Kavirondo Sorghum was obtained from near Maseno in the Kavirondo district of Kenya. Here the annual rainfall is approximately 60 inches and the altitude above sea-level 4,800 ft. The climate may be described as moist and tropical. Such conditions could scarcely be expected to produce a plant with marked drought-resistant qualities, and,

since this sorghum has proved itself distinctly drought-resistant, it may be suggested that at least one of the types from which it is descended has reached Kavirondo from the dry country of the Sudan via Uganda, by means of native migration and trading. In fact, it appears probable that most of the sorghum varieties, widely cultivated by the natives of Kavirondo, have had a similar origin.

The Perennial Kavirondo Sorghum has yet to undergo extensive trial in ordinary farming practice, but for conditions in East Africa there can be little doubt as to its superiority over the many introduced sorghum varieties which have been tried. The crop attains a height of fully eight feet, and the yield is distinctly heavier than that of most introduced varieties. Susceptibility to disease has been a feature of these varieties, whereas the Perennial Kavirondo Sorghum, although not completely free from disease under Kabete conditions (which are probably not the most favourable), is affected only to a slight degree. The most common form of disease is a sugary excretion from the inflorescences which has been attributed to attack by a *Sphacelia* species of fungus. This condition is common in native *mtama* crops, and is frequently severe in newly introduced varieties of sorghum.

Summary

The Perennial Kavirondo Sorghum has been grown experimentally as a fodder crop during the past five years. The original material was obtained from the Central Kavirondo area of Kenya and is believed to have resulted from natural crossing between grain sorghum in native cultivation and *S. verticilliflorum* Stapf, a common indigenous plant. Trials have shown that the crop is perennial, is very readily established from seed, produces heavy yields of green matter and is suited to aftermath grazing. Experiments with cattle failed to show that cyanogenetic properties are important. The crop has shown marked drought-resistant properties, and is expected to prove of value in the drier mixed-farming areas of East Africa, with annual rainfall 20 to 30 inches, where it may be used for ensilage, feeding green, and as reserve dry-season pasturage. In both European and native areas of this type, the crop offers the possibility of combined use as fodder for storage and as a temporary grazing ley in rotation with cash and food crops. Selection work on the Perennial Kavirondo Sorghum is indicated.

Acknowledgments

Grateful acknowledgment is made of the assistance received from Mr. V. A. Beckley, Senior Agricultural Chemist of the Department of Agriculture, who provided the chemical analysis given in the text, and to Dr. H. S. Purchase, of the Veterinary Research Laboratory, who kindly arranged the additional test for cyanogenetic properties.

FIG. 1
Inflorescence of 'Black' type.

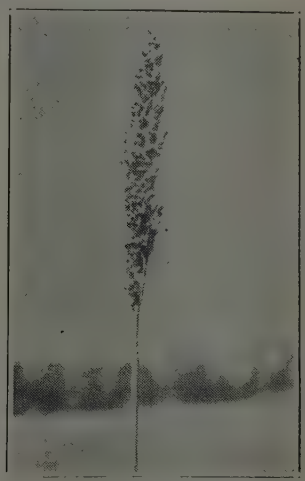

FIG. 2
Inflorescence of 'Mtama-like' type.

FIG. 3
In condition for ensilage, 13 weeks from sowing.

FIG. 4
Cattle grazing aftermath.

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Flax Dodder
Approx. natural size.

Flax Dodder
Approx. 2½ multiplication size.

DODDER

By R. M. Nattrass, B.Sc. Agric. (Lond.), Ph.D. (Lond.), D.I.C., Senior Plant Pathologist, Kenya Department of Agriculture

Dodder is the popular name given to members of a group of parasitic plants belonging to the genus *Cuscuta*. There are more than 100 species, some of which are represented in most countries of the world, and a number are distributed throughout Africa. They are all small annual, or rarely perennial, climbing plants which are parasitic on a wide range of plants and all are characterized by twining leafless stems and tight clusters of small flowers. Each species is restricted to a narrow range of host plants, but some are more catholic in their tastes than others and attack a number of genera. The best known species is *C. trifolii*, which commonly attacks clover and lucerne in Great Britain, but has also been found on other leguminous crops, as well as potatoes, beet, carrots, etc. In Africa the species attacking clover and lucerne is *C. chinensis*, which is also widely distributed throughout the warmer parts of Asia, China and Australia. Two common species on wild plants in Kenya are *C. planiflora* and *C. obtusiflora*. The species which attacks flax is *C. epilinum*, which, as far as is known, does not attack any other plant except hemp and species of *Camelina*. This latter plant is a common weed in flax fields. *C. epilinum* is not a native of Africa but a comparatively recent introduction.

The different species of dodder which attack farm crops resemble each other fairly closely. The following account can be applied in essentials to any one of them.

When mature the dodder plant consists of a tangled mass of bright yellow, reddish or reddish-brown threadlike stems. These bear no leaves but produce numerous clusters of small sessile bell-shaped flowers. The colour varies from white, green or white tinged with red, according to the species. Those of flax dodder are pale green and in tight clusters of five to six flowers, each single flower being about 3 mm. in diameter. The seeds are borne in four seeded capsules; they are usually smaller than those of the plant attacked.

The embryo of the dodder is simple and threadlike, and is coiled spirally round the fleshy albumen. Seed will germinate at a suitable temperature in from five to eight days. It is stated, however, by Lansdell, K. S. (*Journ. Dept. Agric.*, Pretoria, Reprint 45, 1923), that under natural conditions, after a dormant winter period, the seeds (*C. chinensis*) germinate a month later than the majority of other seeds sown in the ground with them at the same time. By so doing there is more likelihood of the seedling reaching a victim. On germination the threadlike coil unwinds and lengthens, the swollen extremity elongating and growing into the ground. The upper portion of the seedling then grows upwards into the air. This is the only period during which the plant leads an independent existence, and it is during this period it must search for and find a suitable host plant if it is to survive. The seedling has no chlorophyll, and is therefore dependent on the meagre reserves supplied in the seed. Meanwhile the upper portion elongates considerably in search of a victim, on reaching which it attaches itself by coiling round the stem. If no suitable plant is reached the young dodder plant dies. It has, however, been shown that (*ibid.*), with one species at any rate, it can survive independently for a period of from six to nine weeks.

The twining stem is furnished with suckers called "haustoria," which occur together in short rows. These haustoria fasten themselves to the host's stems and penetrate the living tissue, extending through the cortex to the vascular bundles. Once having made contact growth of the parasite is rapid, the stems branching and spreading to neighbouring plants so that a considerable area quickly becomes involved. There is now, of course, no contact with the soil, neither has the dodder any green leaves with which to manufacture food material. Its nutriment is derived solely from the plant attacked by means of the haustoria, which can be seen at intervals along the stem.

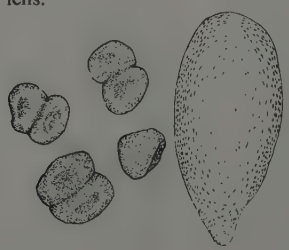
Dodder flowers profusely and produces numbers of small seeds which may not only further extend the area infested but also render subsequent crops liable to attack. So tenacious of life is this plant that even small pieces of stem broken off and carried some distance can establish themselves and start fresh centres.

The only species of dodder which are likely to come to the attention of farmers are those attacking flax, clovers and lucerne. Tobacco is also occasionally attacked. Except in very exceptional circumstances, clean land can only become contaminated by the introduction of the seed of the parasite as an impurity of the crop seed. There is little doubt that flax dodder has been introduced into Kenya in this way. Both flax and clover dodder are widely distri-

buted, and probably occur in all countries where these crops are grown. The importance of using clean seed cannot be over-emphasized. The intimate contact that dodder makes with its host makes it inevitable that seed from an infested crop will carry with it at least some of the dodder. In order to safeguard farmers in the United Kingdom, under the Seeds Act of 1920 the presence of dodder in seed must be declared if it occurs to an extent exceeding one seed in 1 oz. of wild white clover, or in 2 oz. of alsike clover, or in 4 oz. of red clover, flax or lucerne. Similar legislation is enforced in most countries. Where no such legislation is enacted clean seed may be an exception. Thus as late as 1936, 81 per cent of all Chilean samples of red clover seed contained dodder, whereas of the English samples only 0.92 per cent were contaminated.

The danger can be best appreciated when it is considered that a 1 lb. sample of clover seed containing 1 per cent European clover dodder seed would carry about 18,000 seeds of dodder, or 0.1 per cent, i.e. 1,800, would, if sown at the rate of 8 lb. per acre, distribute three dodder seeds in each square yard.

Flax dodder seeds are about 1.5 mm. in diameter and are frequently united in pairs, which characteristic makes their recognition easy. The seeds of most dodders are smaller than those of their host, but some are of nearly equal size. When consignments of seed are tested for dodder the whole of the "warehouse sample" must be examined, a laborious process which is much facilitated by means of the dodder machine, which feeds the seed on to a travelling endless band of black velvet under a fixed reading lens.



2 mm.
Seed of Flax and Dodder
(Same scale)

Dodder seed can be removed from bulk by means of special cleaning machinery. The separation of flax seed and dodder presents no difficulty owing to the difference in size and shape of the two seeds, but with others sieves and indented cylinders are not effective. Clovers are more difficult. Here advantage is taken of the rough coating of the dodder seed. One machine, the Dossier, uses velvet linings, while the magnetic machine employs a fine magnetic dust with which the bulk is treated. The polished surface of the clover does not hold the powder, but the surface of the dodder is sufficiently rough to retain some of it. The bulk is then passed in a slow stream over a magnet, which holds particles on which the powder adheres and thus effects a separation.

Control Measures

All direct control measures must aim at destroying the plants before the flowers have set seed as, not only may such fallen seed extend the area attacked, but also, by remaining dormant in the soil for periods of anything up to ten years, render subsequent crops liable to attack. It is important therefore that when dodder is found steps should at once be taken to destroy it, however small the affected patches are. This is best done by burning on the spot. The patches should be covered with straw or chaff, sprinkled with kerosene, and fired. It is a mistake to attempt to remove the dodder by digging or raking, as small pieces, which are almost certain to be dropped and scattered, will only serve to spread the pest. It is better to employ drastic treatment in the early stages than to run the risk of extending the existing area or contaminating clean land with fallen seed. Infested patches may also be destroyed by spraying with a 10 to 15 per cent solution of sulphuric acid, but this is not a method to be used on a large scale without special apparatus. As flax is an annual, these are the only measures recommended, as both host and parasite will be killed. With perennial crops, such as clover and lucerne, other chemicals may be used, e.g. a 15 to 20 per cent solution of iron sulphate or a 5 per cent solution of copper sulphate. This treatment, which aims at killing the dodder and allowing the lucerne or clover to recover, is not always satisfactory. Other methods have been suggested, such as attempting to smother the dodder with a thick layer of chaff or other substance and covering with an inch or so of soil, the idea being that the clover will break through but not the dodder. With any crop, if the patches are small, as they will be if vigilance has been exercised, burning is the safest way of dealing with it.

If not burnt, care must be taken in the disposal of any infested straw, as the seed may easily be returned to the land in a viable condition if the straw is used as litter or, in the case of clover and lucerne, fed to stock. Even dodder seed in linseed cake fed to stock has been known to reach the land in manure with its germination capacity unimpaired.

THE FAILURE OF PURE AND HIGH-GRADE EUROPEAN CATTLE IN HOT CLIMATES

By M. H. French, M.A., Ph.D., Dip. Agric. (Cantab.)

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During the last two years there has been a considerable increase in the literature dealing with the effects of climate on animal production. Many authors have discussed the reactions of European cattle in hot climates, and a brief discussion of this problem will be of value to stockowners in East Africa.

Local Zebu cattle are not sufficiently economic to satisfy the more intensive conditions of European farming, and the breeding and selection of improved local types is an expensive and life-long occupation. Most farmers therefore decide to get a much more rapid improvement by using bulls of recognized European breeds to grade up their Zebu stock. The Veterinary Department foresaw this trend of development and much time and money have been spent in experimentation. The results obtained have been discussed in the Annual Reports of the Veterinary Department for the last five years and summarized in the *Empire Journal of Experimental Agriculture,* Vol. 8, pp. 11-22, 1940.

Stated briefly, the results obtained were that half-grade animals were superior to the Zebu in every way. Higher grading towards a European breed invariably caused trouble, and the three-quarter and higher grades of cattle were definitely inferior to the half grades and often less economic than the better Zebu types. The number of constitutional failures increased with higher grading to the European type, so that conformation as well as productivity left much to be desired.

Good types of high-producing animals have been imported to the Government farms, and a good measure of productivity has at first been obtained. Breeding troubles then occurred in a high percentage of cases, and the productivity in subsequent seasons has declined. In addition to this degeneration of imported stock, the first generation of stock born in this Territory were inferior to their imported ancestors. Subsequent generations declined still further unless fresh blood was continually imported.

It is interesting now to consider the reactions of farmers to this information because, generally, one of two attitudes is adopted. Either the farmer says, "Well, what else could one expect from Government activity," or he says, "Well, this may be true in Mpwapwa and Dar es Salaam but, on my farm where the climate and management, etc., are so much better, I am certain I could put up a good show." Actually, I have seen many constitutional failures amongst the high grade stock of farmers and, in other cases, farmers who realize they have graded too highly are using Zebu bulls to make their dairy herds more economic. The experience of the Government farms has been disregarded and many farmers are covering the same ground to their financial disadvantage.

The object of this article is therefore to show farmers that the same troubles are widespread throughout the tropical and sub-tropical areas of the world. It is not merely a Tanganyikan problem and the causes lie in the European breeds and their inability to adapt themselves adequately to an environment so dissimilar from that in which the breeds were originally developed.

Different breeds of animals, different systems of feeding and management, and different climatic conditions will obviously occur between Brazil, Texas, Louisiana, Jamaica, the Gold Coast, South Africa, Tanganyika, India, Queensland and the Philippine Islands, yet from these countries have come repeated statements that the grading up of local cattle with European bulls leads to constitutional failures. The level at which degenerative tendencies become obvious varies with the breed of animal, the climate and the management, but nowhere, so far, have high grade European cattle adapted themselves completely to tropical climatic environments. This does not mean that European cattle cannot do extremely well inside the tropics if they live at an altitude at which the climate simulates that of temperate zones. Under such conditions, very little degeneration of type is observed, but once the animals are subjected to tropical and sub-tropical conditions their powers of adaptation become overtaxed.

That the poor development and retarded growth rates of young stock is not due to diets deficient in some essential constituent has been demonstrated in Brazil, Jamaica, India and Tanganyika. I have also shown recently that high-grade oxen can digest local foodstuffs just

as efficiently as Zebus. With their larger stomach capacities, high-grade stock should therefore be just as capable of obtaining enough nutrients as the Zebu. Why, then, is it impossible to rear heavy-producing high-grade stock successfully in tropical environments? The answer has not yet been worked out completely, but one factor of enormous importance has become generally recognized, i.e. the inability of high grade and pure-bred European cattle to eliminate heat sufficiently rapidly to maintain normal body temperatures.

It is perhaps only natural that the influence of high atmospheric temperatures should have been the first of the tropical climatic factors to be studied, because we all know the lassitude and lack of tone which follow a prolonged stay in a hot region. Most workers have recorded factors which are governed by the prevailing air temperatures, but it is well to remember that most of these are secondary to the effect of high air temperatures on heat elimination.

European breeds have been evolved under climatic conditions which necessitated the conservation of heat to maintain a normal body temperature. The Zebu, on the other hand, has been evolved under tropical and sub-tropical conditions where it has been more important to prevent overheating of the body. Naturally the European type will be less efficient than the Zebu in hot climates because its heat-regulating mechanisms will be functioning in a reverse and unfamiliar manner.

All body functions (eating, digestion, blood circulation, movement, and reproductive activities) develop heat. The larger, quicker-growing European animals produce greater quantities of heat than the smaller Zebus and so, not only are the European animals less able to eliminate heat than Zebus but they have more to dissipate if they are to maintain normal body temperatures. It is obvious that body temperatures can only remain normal if the rates of heat production and elimination are the same. Once the rate of elimination fails to keep pace with the rate of production, heat is stored in the body and the body temperature must rise.

This is exactly what happens in pure and high-grade cattle in high air temperatures, and the result is that these animals spend a considerable part of each day in a state of fever. Observations from all parts of the tropics and sub-tropics agree that the rectal temperatures of European and high-grade cattle reach high levels in the middle of the day and that this febrile state is prolonged for a considerable time after the air temperatures drop towards evening. The fact that the return to normal body temperature lags behind the evening decline in air temperature indicates that a large amount of heat is stored in the body during the day and that the rate of elimination is significantly lower than is desirable. With Zebu cattle there may be a slight increase in rectal temperature when grazing during the midday heat, but the increase is slight and quickly returns to normal as the air temperature drops. Certainly the Zebu does not reach a state of fever and must possess a better mechanism for heat elimination than European types.

It is well known that within any given breed certain individuals possess superior powers of adaptation to high external temperatures, but the variations between Zebu and European cattle are too great and too constant to be other than significant breed differences. The Zebu possesses superior powers of heat adaptation to the Aberdeen-Angus, Shorthorn, Sussex and Hereford breeds of beef cattle and to the Friesian and Ayrshire milk breeds. The different European breeds, however, are not all equally inferior to the Zebu; for instance, the Friesian appears better able to withstand tropical conditions than the Ayrshire, and the Hereford better than the Aberdeen-Angus. The powers of adaptation of grade European x Zebu cattle lie between those of the parent types, but the higher the crossbreds are graded to the European type the less suited do they become to tropical conditions.

The body temperature of any animal is a measure of its efficiency to control heat elimination, and the failure of European animals to maintain normal rectal temperatures is therefore a clear indictment of their suitability to tropical climates. Much work has, however, been done to determine what causes European animals to lose their thermal control, and a brief summary of the chief heat regulatory mechanisms will be given before proceeding to a discussion of the metabolic changes involved and their repercussions on other body functions.

Normally, hot-bodied animals lose heat to the surrounding atmosphere by radiation, but higher air temperatures reduce the rate of heat lost by this means and reserve mechanisms are then called into operation. In cattle, however, the presence of a coat of long hair interferes with heat elimination, because a layer of air gets enmeshed in the long hairs and prevents the free exchange of heat between the skin and the air. With Zebu cattle the hair is short and fine and lies close to the skin, offering the minimum obstacle to free heat exchange. In

European breeds the hairs are much longer and stand more erect, so that the free exchange of heat between their skins and the outside air is impeded. Here then is a genetical factor which tends to reduce the powers of heat elimination in European cattle as compared with Zebus.

Once the heat lost by radiation is insufficient to keep body temperature down, the body increases its blood circulation through the skin, so that the maximum amount of heat shall be lost by this physical process. With increasing air temperatures it is found that all breeds of cattle show increased pulse rates, but the increase is very much greater in European types than in Zebus. When the heart is forced to work extra hard for long periods each day it is liable to become overtaxed and lose its efficiency. This is very much more liable to occur in European than in Zebu cattle.

The next physiological process normally called into play, to allow heat elimination to keep pace with heat production, is sweating. By this mechanism a film of moisture is secreted on the skin, and by its evaporation a large amount of heat is dissipated. Unfortunately, cattle sweat very little and this avenue of heat elimination is of little significance, but experiments have shown that Zebu cattle have nearly twice as many sweat glands per unit of skin area as are found in the skins of European breeds. Here again, although the total effect is small, the Zebus have another genetical superiority over European breeds of cattle, and experiments have proved that the amount of water vaporized through the skins of Zebu cattle is one and a half to two times the amount transpired from European cattle as soon as the air temperature rises above the region of thermal neutrality for cattle.

Instead of sweating, cattle eliminate water vapour through the lungs to cool themselves. As temperatures rise everyone must have noticed that cattle respire at increasing rates. Actually this provides the most spectacular difference between European and Zebu cattle, because, once the air temperature rises above 80° F., Zebus respire faster but the increase in respiration rates of European cattle is many times that of the Zebu increase.

Everyone is familiar with the spectacle of a mixed herd of European and Zebu animals out at pasture in the middle of the day, and must have noticed how the Zebus continue to graze long after the pure and high-grade European animals have sought the shelter of a shady tree. The Zebus continue grazing quite comfortably (with a slightly increased respiration rate) whilst only a few yards away European animals are standing in the shade (to get maximum surface cooling), panting at a very fast rate, often with their mouths open and saliva dripping from their jaws. This is a most convincing demonstration of the superiority of Zebus over European cattle in hot climates.

The failure to maintain body temperatures by European cattle in the tropics is therefore not due to a failure of the normal physiological processes which promote heat elimination. In fact, these processes work at a much higher rate in European than in Zebu cattle, but still the rate of heat production outstrips the rate of elimination and body temperature rises.

As has been pointed out earlier, all body activities develop heat, and since the European breeds have genetic potentialities which allow them to grow quicker, and form flesh, fat and milk at higher rates than the Zebu, there is a greater heat production in European cattle than in Zebus. Even the eating, rumination and digestion of food generates an appreciable quantity of heat and, since the larger European cattle need more food for maintenance purposes alone, it is obvious that they will always be at a disadvantage when compared with Zebus. It is this ability to convert larger amounts of food into flesh and milk, and the consequent more highly intensified metabolic system, which is probably the underlying cause of the failure of European cattle to adapt themselves completely to high air temperatures. These breeds with their high metabolic capacity have been evolved in areas with low air temperatures for the greater part of the year and where heat elimination is not a serious problem. When they are introduced to areas where high atmospheric temperatures are the rule, the reduced rates of heat elimination cause distress and febrile conditions. This is in keeping with the fact that the smaller Jersey cows, with their lower food requirements for maintenance and consequently lower heat production, have proved the best European dairy breed for Jamaica and the Southern United States.[1]

[1] It is likely that one factor in the Jersey's favour is a purely geometric effect of its small size. The ratio of surface (i.e. both radiating area and sweating area) to weight decreases with greater total size and with increasing compactness of form. Thus a square heavy Shorthorn would have a lower proportion of surface to weight than an animal of a more leggy breed, and in general European cattle would in this respect compare unfavourably with the smaller, lighter built tropical breeds in their ability to keep the body temperature down.—R.E.M.

What then will be the further effects of overheating the bodies of European cattle? The first effect is the feeling of lassitude already mentioned, and probably the second is a reduction of appetite. With fever, appetite is never as high as when body temperature is normal and this lowered food intake will assist the distressed European cattle by reducing the quantity of heat generated from alimentation. On the other hand, a reduced food consumption means that less nutrients are available for productive purposes and the rates of growth, fattening and milk production will be lower than the genetic potentialities of the breed. This is in fact what has been observed in most parts of the tropical and sub-tropical regions. High-yielding milk cows can be imported and will do well for a period, but eventually their yields drop to much lower plane and, similarly, high grading to European bulls does not give corresponding increases in milk production.

Overheating also leads to high rates of water vapour elimination, and to counteract this desiccating tendency it is observed that European types of cattle drink much larger quantities of water than Zebus. The large water intake leads to a greater output of less concentrated urine and the kidneys are forced to work at a much greater rate.

It has also been shown that the hæmoglobin index of the blood is reduced by rises in temperature and when the blood of Zebus is compared with that of European cattle it is found that the latter have considerably lower hæmoglobin and red cell counts, whereas in more temperate regions the hæmoglobin index and red cell counts of European cattle are similar to those recorded for Zebus in the tropics. It is interesting in this connexion that the low hæmoglobin index of European cattle in the tropics is not apparently caused by pathogenic agents and is also not relieved by feeding iron, copper and cobalt supplements at a high rate. There are also indications that high temperatures affect the alkalinity, salinity, non-protein nitrogen and sugar contents of the blood, but the importance of this is not clear. There may, however, be some correlation between the low hæmoglobin content and the increased circulatory and respiratory rates. With the enormous increase in the two latter, a low hæmoglobin is probably of importance in preventing over-oxygenation of the tissues.

There is an undoubted relationship between reproduction and overheating. It has already been pointed out that in imported European cattle breeding troubles occur and the fertility of pure and high-grade cattle is often very low. This problem has not yet been satisfactorily elucidated, but observations are reported showing that overheating in male animals seriously reduces the vitality of spermatozoa, inhibits spermatogenesis, and may even kill them if the body temperature rises to 106° F. Similarly, when European cows are brought in from grazings after midday, they have high body temperatures, and service at this time exposes the sperm to temperatures which may easily damage it. These two factors may therefore be partially responsible for the low conception rates in European cattle in tropical climates.

It has been mentioned above that European cattle can often be seen panting at a fast rate with saliva dripping from their open jaws. It has recently been reported from South Africa that when the body temperature rises to 106° F. in European cattle as much as four gallons of saliva have been collected from bulls out in the sun and as much as two gallons from animals in stalls. This means that there is a considerable loss (up to 2 oz. daily) of mineral salts drained from the body tissues.

A further complicating factor, introduced by the overheating of European cattle, which tends to start a vicious circle is the tremendous increase in the circulatory and respiratory rates. By increasing these rates considerably, the body is able to increase the rate of heat elimination, but they also involve a considerable increase in muscular activity. The latter inevitably results in an increased metabolism, which means that there is an extra quantity of heat generated. Also, as the heat-regulatory mechanism loses control and body temperatures rise, the normal metabolic reactions in the body become deranged and behave as uncontrolled chemical reactions where their velocity varies with the temperature. When this happens there is a considerable unnecessary liberation of heat at a time when heat elimination has already ceased to keep pace with production.

Once the velocity rates of the various biochemical reactions are accelerated by the increased body temperatures, the equilibrium points become shifted. The efficiency of the body then becomes reduced because, once a disturbance in one of the balanced bodily systems has occurred, repercussions of equal magnitude will occur amongst the other systems of the complex. It is almost certain, for instance, that the endocrine balanced system would become disturbed and the results of this alone on various body functions would be enormous, and the same applies to the other

complex biochemical systems on whose smooth running the wellbeing of the body depends.

Enough has probably been said to indicate the enormous importance of air temperatures in determining the degree of success that will follow the introduction of European types of cattle into areas possessing a tropical climate, but temperature is merely one factor in the environment. The influence of the sun and the humidity of the atmosphere are other factors exerting deleterious influences, and both factors exaggerate the effects caused by temperature alone. If this article has drawn the attention of farmers to this very important problem of breed reaction to environment it will have served its purpose. Improvement of Zebu cattle by grading up to European bulls is not merely a question of good feeding and management; there are inherited characteristics in European animals which are working against their complete adaptation to tropical and sub-tropical environments. Some breeds, and these are usually the most improved of the European types, will fit less easily into tropical conditions than others. Farmers embarking on improvement schemes involving European cattle should give considerable thought to the breed they intend to use. Probably the smaller or more slowly maturing European breeds will prove the best.

Although this article stresses the bad results that follow the introduction of European animals, it must not be forgotten that a good measure of improvement will be obtained if the level of European blood in the progeny is kept down to half or less. Selection of better types of Zebu animals is obviously the ideal to aim at, but the time involved will usually make the farmer decide to try grading to a European bull. This will pay so long as the Zebu hardiness and acclimatization characters predominate in the progeny, and on Government farms in this Territory it has been found that animals higher graded than the half-breds are too weighted with European characters to be satisfactorily economic. At higher altitudes or where air temperatures are relatively low the level of grading, beyond which it is uneconomic to breed, will possibly be higher than the half-bred, but every farmer should test this for himself on a small number of animals before risking his whole herd.

It may be asked what should be done once the herd has reached the half-bred stage. There are two alternatives; one is to use a native bull and, on the quarter grade progeny so obtained, use another European bull. Later crossing with native bulls will be needed to keep the level of European blood to half or less. This process is not very satisfactory because of the difficulty in obtaining Zebu bulls from a known milking strain, unless such animals are imported from India. The better alternative, I think, is to select a half-grade bull from a good cow and mate half-grade stock together. Although there may be great variation in type amongst the progeny, it should be possible by rigorous selection eventually to evolve a good strain of animal capable of producing milk or beef economically, but still remaining in harmony with the environment.

ROTATIONAL GRAZING IN CENTRAL TANGANYIKA

In addition to these specific works, grazing reserves are being demarcated throughout the province in order to prevent further erosion, as a first step towards the introduction of a general system of rotational grazing. Two methods are being attempted according to the nature of the area, but in all cases it is important to bear in mind that the reserved grazing shall be within the normal grazing area of the people concerned. Where there is a permanent water supply available and plenty of surplus grazing within reasonable distance, a prescribed area around the permanent water is reserved from the 1st February until the harvest each year. Improved water supplies, in the form of dams or *hafirs,* are created in the alternative grazing areas, designed to provide water for the cattle until the harvest is reaped, so that there is no need to use the permanent supply during the growing season. Examples of this method are the Bwaga, Kongwa and Berege schemes. This type allows the most rapid recovery of the overgrazed areas, as it permits them to be rested for some months every year; but there are many areas where there is no surplus grazing within ready reach. In such places, a different method is required, namely to divide the country into blocks, each of which is in turn divided into two, each sub-division being reserved in alternate years from February to June. This latter method allows the whole of the grazing to be available during the period of greatest scarcity, and in order to demonstrate its benefits on a large scale it has been applied to an area of roughly three miles radius around Dodoma.

Reference: Annual Report, 1939, Provincial Commissioner, Central Province, Tanganyika Territory.

ANTESTIA IN THE NORTHERN PROVINCE OF TANGANYIKA

By F. B. Notley, M.Sc., A.I.C.T.A., Entomologist, Department of Agriculture, Tanganyika Territory

(*Received for publication 20th June*, 1940)

Introduction

It had not been intended to publish these observations until at least another year's records had been obtained, but war conditions have made it unlikely that the work will be continued immediately, and it is considered advisable to publish the results obtained, incomplete as they are, for record purposes.

Studies of *Antestia* incidence have been going on in three districts in the Northern Province of Tanganyika by means of the test spraying of a number of typical native coffee plots in Uru and Arusha, and on all coffee plots on the Coffee Research Station at Lyamungu. The Uru district lies on the southern slopes of Mount Kilimanjaro, near to Moshi, and the various plots are situated at altitudes ranging from 4,000 to 5,000 ft. The Coffee Research Station is similarly situated some eight miles to the west of the Uru district, at an altitude of 4,000 ft. The Arusha plots lie on the side of Mount Meru, above the town of Arusha, at altitudes ranging from 4,600 to 5,000 ft. The plots at the Coffee Research Station are all young, none being more than six years old, and are mostly unshaded or lightly shaded; the plots in Uru and Arusha are mainly older, and heavily shaded with bananas, indigenous trees, and occasionally *Grevillea robusta*.

All plots were tested frequently by the method of test spraying with pyrethrum extract, as described by Le Pelley [1]. Ten trees were tested in each case; most of the plots being about half an acre in size, and none exceeding three acres. Tests were generally made each month, sometimes more frequently.

Seasonal Incidence

Figure 1 shows the average number of *Antestia* per tree of all plots in each of the three districts. (The Coffee Research Station is referred to as a "district" in the following descriptions.) Crosses on the diagram indicate when control measures were undertaken on at least some of the plots in a district. Observations were discontinued in the Uru district in November, 1939. It will be noticed that in all three districts control measures were undertaken only between October, 1938, and April, 1939, and between November, 1939, and February, 1940. At these two periods the diagram shows there was a marked tendency for the numbers of *Antestia* to increase, which was largely checked by the control measures applied. During the intervening period, April to September, although no control measures were applied, there was no tendency for the population of *Antestia* to increase.

In all three districts the main flowering takes place in the short rains (about November), and the crop is harvested mainly in the following August to November.

It will be argued that many outbreaks of *Antestia* have been recorded in the period July to September in this district, which seems to suggest that big increases of population may take place at this time. It should be remembered, however, that at this time the first small pickings are made, in which *Antestia* damage may be very high; the attention of the planter may thus be called to the presence of large numbers of *Antestia* in his plantation. It may well be that the *Antestia* population has been high, without attracting notice, for several months. Unless supported by figures obtained by accurate and frequent test-spraying, such reports of increase of population during these months should be regarded with suspicion.

It is not proposed to discuss these diagrams in further detail, except to point out that in all three districts during the hot season November to February *Antestia*, if uncontrolled, appears capable of doubling its population each month.

Control

In the Uru district arsenite baiting was carried out as the normal routine measure under the supervision of the Kilimanjaro Native Co-operative Union. In the Arusha area pyrethrum dust was used under the supervision of the Agricultural Officer, Arusha. On the Coffee Research Station pyrethrum dust was used on all occasions except the last, in February, 1940, when arsenite bait was used.

It should be noted that the reduction of the *Antestia* population shown after control measures have been applied (as indicated by

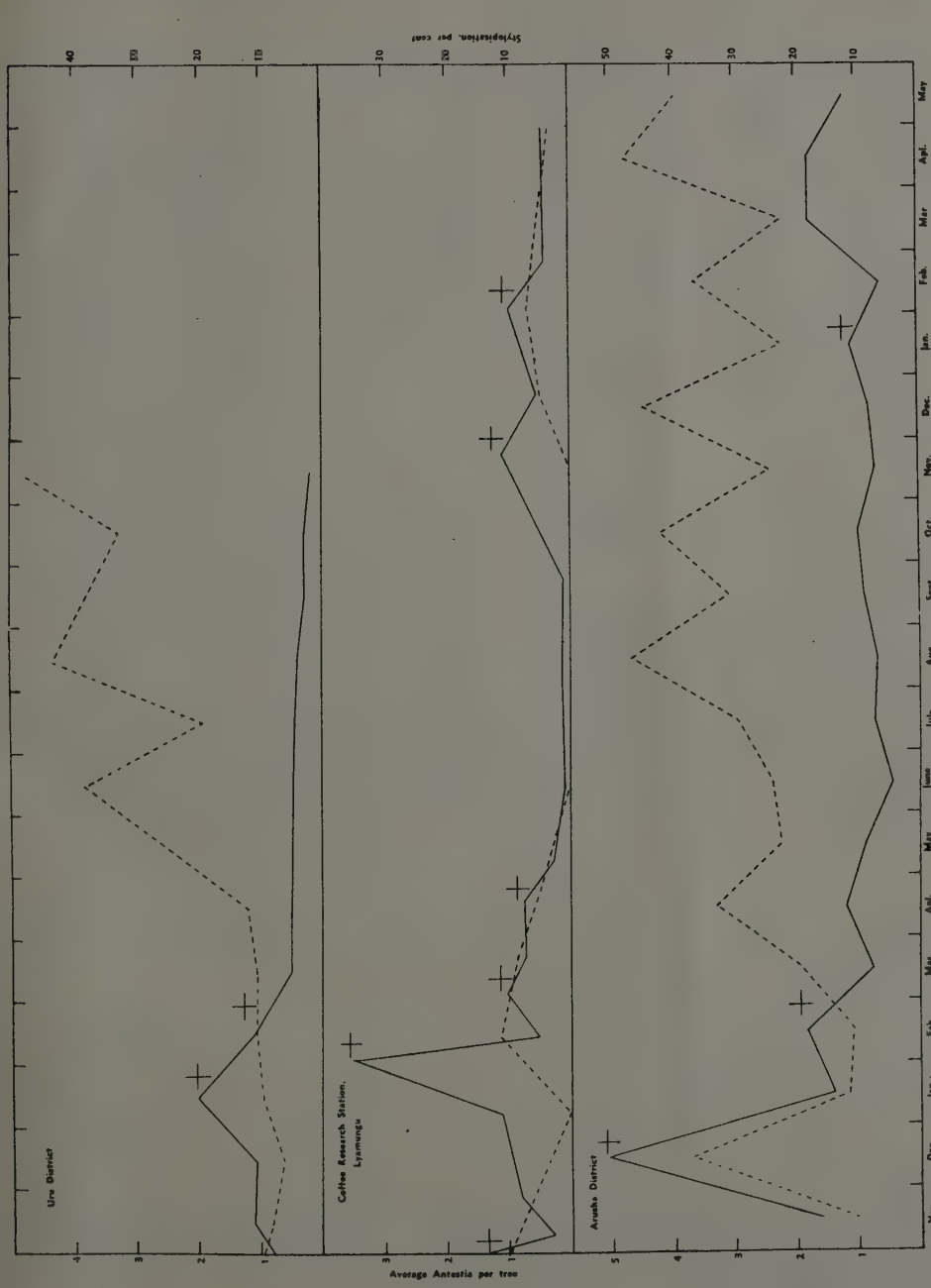
Average Antestia per tree
Stylopisation, per cent
Uru District
Coffee Research Station, Lyamungu
Aruaha District
Antestia, average per tree
Stylopisation, per cent
Nov. 1938
Dec.
Jan.
Feb.
Mar.
Apl.
May
June
July
Aug.
Sept.
Oct.
Nov.
Dec.
Jan.
Feb.
Mar.
Apl.
May 1939

FIGURE 1

crosses on the diagram) is not a measure of the control obtained. The figure for population is the average for all plots in the district, whereas control measures may only have been applied to some of these plots. Accurate figures for pyrethrum dusting are available on all of the plots at the station and show that an average kill of 89.5 per cent, with a standard deviation of 11.7 per cent, was obtained; this kill was obtained with an average application of 5.85 lb. per acre. (Many of the plots are young, and the application is lighter than that normally recommended; Notley [2].) During the period November, 1938, to October, 1939, inclusive, of the twenty plots under observation four did not require treatment, four were treated once only, seven were treated twice, and five were treated three times. A total of 47.8 acres was treated, the total area being 34.9 acres; on the average therefore control measures were undertaken on an area 1.37 times the total area. The average cost therefore at the low figure for application of 5.85 lb. per acre, and at the present price of pyrethrum of Sh. 1/10 per lb., was Sh. 9 per acre, inclusive of labour, depreciation, etc.

The diagrams show that arsenite baiting can be very effective during January and February, and this is confirmed by other experiments on the Coffee Research Station. At other times of the year, however, it is doubtful if arsenite baiting is so effective; many reports have been received of repeated applications of bait being ineffective during the cold weather.

Damage

In two of the districts mentioned above, namely the Coffee Research Station and Arusha, samples of the crops were examined for *Antestia* damage. In Arusha samples of 100 ripe cherries, if any were available, were taken from the trees each month at the time of test spraying; at the Coffee Research Station samples of 100 cherries were taken from each picking of each plot. These were hand-pulped and examined in the laboratory. In examining the samples the object aimed at was to remove all those beans which were stained and which it was thought would be removed by hand-picking when the crop was cured. In a test sample *Nematospora* was demonstrated in 83 per cent of the beans thus selected; this may be taken to indicate certainly that at least the great majority of the damage recorded was definitely that of *Antestia*.

In estimating the amount of total damage, the methods followed in the two districts were slightly different. Since the amount picked at each picking at the Coffee Research Station was known, the total amount of damage could be calculated exactly, and this was done. In Arusha, however, these figures were not available, and the amount of damage was estimated by averaging the amount of damage in the four monthly samples during which the majority of crop was picked, ignoring the early and late samples. The figure for *Antestia* incidence is the average figure for the whole crop season per tree.

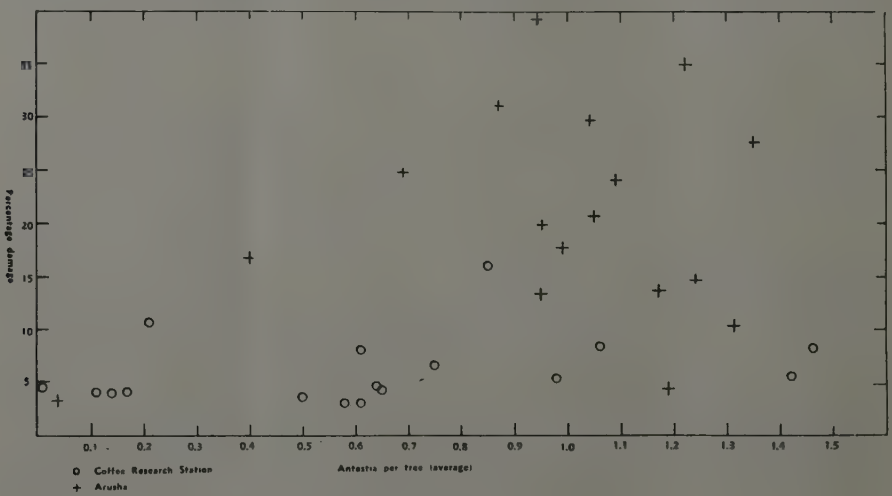

FIGURE 2

Fig. 2 summarizes the results. The figures for the Coffee Research Station are shown as round dots, those for the Arusha district as crosses. There seems to be an obvious positive correlation between the average number of *Antestia* per tree and the amount of damage. Treated statistically, this correlation is not quite significant (r=.334, which lies between the .1 and .05 level of significance), but there are only a rather small number of observations available.

It is not to be expected that the correlation should be very close. The amount of damage will depend not only upon the number of *Antestia* present, which is the only factor taken into account here, but also upon the percentage of these which are infected with *Nematospora*, and also, inversely, upon the amount of crop, since a given number of *Antestia* will cause a smaller percentage damage in a big crop than in a small one. Only one of these factors, the number of *Antestia* per tree, is taken into account here.

The important point is that although as a whole good crops were obtained in this season, the percentage damage was very high. It appears that in this district an average of only one *Antestia* per tree throughout the year will cause a total damage of about 16 per cent. It follows that to prevent serious loss of crop *Antestia* must be controlled in this district at a very low figure; and it is suggested that it is an economic proposition to attempt to keep *Antestia* below an average of one per tree at all times in every block of coffee. The average over a large area will thus be kept considerably below one per tree.

The average percentage damage over all plots in an area showed progressive fall during the picking season. The figures are as follows:

Coffee Research Station	
July	17·8, 15·0
August	14·5
September	10·3, 7·8, 7·2
October	8·9, 6·3
November	4·3, 4·4
December	5·2
January	4·7
Arusha	
June	40·9
July	31·1
August	23·7
September	20·3
October	20·3
November	13·8
December	12·9

Examination of samples of cherry from all estates where station experiments were in progress were made; the results indicate a much higher percentage loss from *Antestia* than is generally realized, the average loss from all samples examined (133) being 14.9 per cent.

One further point should be emphasized, and that is that the loss reported from the curing works when the coffee is being hand-picked for *Antestia* is *not* the total loss from *Antestia*. The majority of *Antestia*-damaged beans are floaters, and are extracted from the coffee in the washing channel. They thus never reach the curing works. A large proportion of lights, which are attributed to lack of rain, too much rain, Thrips, over-bearing, or any other cause which may seem plausible to the planter, will on examination prove to be due to *Antestia*.

Parasitism by Corioxenos

The internal parasite of *Antestia*, *Corioxenos antestiae* Blair, discovered by Kirkpatrick [3], has received special attention. It was known to be present only in the Northern Province of Tanganyika, but has recently been reported by Taylor [4] from Uganda. The broken line in Fig. 1 represents the percentage infestation of *Antestia* by *Corioxenos*, as determined by external examination of all adult *Antestia* brought down by test-spraying. One or two points are worth notice. At the Coffee Research Station, where the coffee is almost entirely unshaded, *Corioxenos* has been of little importance; in the other two districts its importance has been considerable. A study of the individual records suggests that *Corioxenos* requires rather a high population to become common, but remains common even in low densities of *Antestia* population during the cold weather. There seems to be no indication that either pyrethrum dusting or *Antestia* baiting adversely affects the percentage parasitism by *Corioxenos*, except by reducing the host population density.

The presence of *Corioxenos* as an important controlling agency only in this district makes it very dangerous to conclude that the results given here may be applied elsewhere, where *Corioxenos* is not present.

Conclusions

It may be tentatively concluded that in this district *Antestia* populations tend to increase during the hot season, October to March, and to remain stationary, or to decrease, during the cold season, April to September. Correlation

of population figures and damage suggests that loss due to small populations of *Antestia* is more serious than has been realized. Considerably greater expenditure on control measures may therefore be justified.

It is suggested that control measures should commence in October, and that from October to the end of March the *Antestia* population should not be allowed to increase above an average of one per tree in any part of the population. Once the crop is off, and until the rains commence, arsenite baiting may be used. If this fails, or if the population is still dangerously high at the end of March, pyrethrum dusting should be applied where necessary. It seems probable that in this area, if the population of *Antestia* can be reduced to a minimum by April, it will remain very low throughout the cold season, and no further trouble need be expected until October. The method at present recommended for control is arsenite baiting during the hot dry weather, and pyrethrum dusting at all other times. It is suggested that the standard to be aimed at is a population of *Antestia* of less than one per tree in any block.

Acknowledgments

I wish gratefully to acknowledge the help of Mr. T. C. Cairns, Agricultural Officer, Arusha, and Mr. J. R. Curry, Agricultural Officer, Moshi, who made possible and supervised the work at Arusha and Uru respectively; of Mr. J. I. Thompson, who gave assistance with the statistics, and of Mr. S. M. Gilbert, Chief Scientific Officer at the Coffee Research Station.

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MAIZE STORAGE

The article in the Journal on the storage of grain prompts me to send a description of my granary, which is just a hut, with 9 inch brick walls, laid in *dagga* [mud or clay plaster], with no reinforcement, and with a cement floor and roof.

To make the roof, an ordinary one, it was first made of light gum poles, placed close together, with reeds laid over the joints, and on this a 3 inch layer of concrete was placed. The end of the rafters rested on the middle of the wall, so that when the concrete was laid it was flush with the outside thereof. The laths, or *mbariro*, used for tying the rafters together served to hold the concrete from slipping down while still wet, a start being made at the top.

When the concrete had set hard it was covered with thatch, to keep the granary cool and shoot the water off the wall, which was tarred outside and plastered inside with the grey subsoil from sandy vlei. The manhole was made in the wall at the top, and a door was made to fit it; when the bisulphide or carbon has been put in, this is plastered thickly all round with *dagga*, and the whole thing made airtight.

On the cement floor three layers of broken bricks were placed, and the joints were filled with dry sand. The grain is poured on this, and when taken out there is no sign of dampness down to the last mealie. Mealies have been kept in this granary for two years in perfect condition. It is about 12 feet diameter inside, the wall is about 8 feet high, and the capacity is about 150 bags.

It might have been better to have reinforced the wall with a strand of barbed wire, but the solid cone of concrete on top seems to make it unnecessary.

The whole thing is absolutely effective, no mode of construction could cost less, and to all appearances it will last indefinitely.

I should be pleased for anyone interested to call and see it; my place is three miles from Marandellas, on the road to the Ruzawi School; Dr. Hopkins and Mr. Marshall know it. It would be well, however, for any intending visitor to let me know beforehand, as I am away from home a great deal.

J. H. FINCH.

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EMPIRE PRODUCTION OF DRUGS

I—STRAMONIUM

By P. J. Greenway, Systematic Botanist, East African Agricultural Research Station, Amani

Introductory Note

Last October, the Medical Research Council of Great Britain issued a list of drugs for the guidance of those concerned with the compilation of formularies and those responsible for drug manufacture and distribution. The Council's main object was to examine the lists of the drugs which are imported into Great Britain and to recommend substitutes that can be obtained at home or within the British Empire. The Council also found that important drugs are used for purposes for which they are not essential.

In the list a number of drugs bear the remark "Production within the Empire should be encouraged", but this is not as easy as it sounds and not to be undertaken lightheartedly, for considerable knowledge of the subject is needed. In this series of articles an attempt will be made to indicate the characteristics and requirements of some of the chief drug plants the cultivation of which is possible in East Africa.

Stramonium is one of the drugs listed by the Medical Research Council, and, judging from reports received from England, growers there are being encouraged to increase production along with other drugs such as henbane and belladonna, which are also considered as essential. British supplies of stramonium were mainly derived from Germany, France, and Hungary.

The genus *Datura,* to which stramonium, or thorn apple, belongs, is represented by about eight species in East Africa. Of these about four are escapes and have now become naturalized; the others, which include the "Moon Flower" or "Angel's Tears," are commonly found in gardens at the higher altitudes.

Datura Stramonium L., from which the drug stramonium is obtained, is an erect, branched annual herb up to about 4 ft. tall. The leaves are alternate, stalked, roughly triangular in outline with the margins coarsely lobed or toothed; in the forks of the branches a leaf and a solitary flower with tubular calyx and large white funnel-shaped corolla are produced. The fruit is an oblong spiny capsule, about 2 in. long, opening by four valves; the numerous seeds are dark-brown or black, kidney-shaped, with net markings. *Datura Tatula* L., another source of stramonium, is a closely related plant with purple stems and leaf-stalks and dirty purplish flowers. It is perhaps only a form of *D. Stramonium,* with which it is often found.

Distribution

Both plants are found as local weeds in East Africa, from about 3,000 ft. upwards, *D. Stramonium* being the most common. In places in Tanganyika it is a pioneer species in recently abandoned rye fields, European vegetable gardens and to a certain extent in native gardens, especially near huts. It has been observed in quantity in shallow roadside drains on volcanic soils in Kenya.

It is thought to be a native of the shores of the Caspian Sea, but is found commonly on waste ground throughout the temperate and warmer regions, and is abundant in South Africa.

Cultivation

Stramonium likes a rich well-drained soil. The land in which it is to be cultivated should be well and deeply dug or ploughed and cleared of all weeds. The seeds should be thinly drilled in rows 2 ft. 6 in. part, or sown broadcast very thinly, and lightly harrowed. When large enough the seedlings should be thinned to 8 to 12 in. apart in the rows, but if broadcast the spacing should be wider. During growth the land should be kept weeded.

Harvesting

The drug stramonium consists of the dried leaves and flowering tops of the plant, collected when in flower. Curing consists only of careful drying. This should be done as quickly as possible by exposing the leaves and tops to the air in a shady place or by placing them in an artificially heated drying room at about 100° F. They should only be dried sufficiently to prevent them from going mouldy in transit. A yield of 700 lb. of dried leaves per acre has easily been obtained in Kenya.

In the properly prepared product the leaves should be dark-greyish green, much shrivelled

and twisted as the result of the drying. The odour of the drug is not strong, but characteristic, and the taste unpleasantly bitter.

For export the dried product is generally packed in hessian bags or bales of 56 or 112 lb.

Standard Required

To conform to British Pharmaceutical Standards, the drug stramonium should contain not more than 2 per cent of foreign organic matter, not more than 20 per cent of its stem, not more than 1 per cent of its stem having a width greater than 4 mm., and not less than 0.25 per cent of the alkaloids of stramonium calculated as hyoscyamine. Ash, not more than 20 per cent. Acid-insoluble ash, not more than 4 per cent.

The seeds of *D. Stramonium* and *D. Tatula* are also acceptable to the British Pharmacopœia.

Uses

The drug is chiefly used to relieve the spasmodic contractions of the bronchioles in asthma. *D. Stramonium* is also one of the chief sources of the alkaloid hyoscine, which is much used as a hypnotic, especially in mania, and in cerebral excitement, such as occurs in alcoholism. As a rule, hyoscine produces a sensation of fatigue and drowsiness, which is quickly followed by sleep. *D. Stramonium* and another, *D. Metel* L., are used for chest complaints by the natives, the flowers and leaves being smoked in cigarettes, which have a drugging effect. The seeds are narcotic and are put into native beer to make it more intoxicating. They are also used for criminal poisoning. A green dye is obtained from both plants.

Market Quotations

At the time of writing the last open-market quotation for stramonium leaves is for the end of December, 1940, when in London there were offers of Continental at Sh. 130 per cwt. ex store duty paid (nominal) and Indian at Sh. 80, duty free. In New York, $0.35 to $0.40 per lb. for Continental stramonium leaves, and $0.30 to $0.35 per lb. for seeds.

THE BRITISH SCIENTIFIC ADVISORY COMMITTEE

By means of the Scientific Advisory Committee, the appointment of which is announced this morning, the scientific workers of the country are given a more defined place in the national effort. The distinguished men, acknowledged leaders in their own branches of science, who form the new committee will bring more than their individual, or even their combined, abilities to the services of the nation. They will establish a centre and rallying point and be a means of releasing and employing scientific resources and skill. They will also be a channel of communication through which the spontaneous suggestions of scientific workers may be examined and tried.

The advisory powers of the committee will be employed at the instance of the Lord President of the Council, who will indicate particular problems for investigation, or of Government Departments which may ask for assistance in selecting suitable men to undertake particular lines of research. In exercising this function the members of the committee have a knowledge of varied and wide fields of science, and of the men engaged in scientific work, which will give access to resources that, in a mechanical and scientific war, must be utilized to the fullest extent. Here, it seems, the committee is to be at the disposal of the Government.

Even more significant is the conferment on the committee of the duty of seeing that no new scientific or technical developments go neglected. The committee will therefore be a sort of examining board for original ideas, which, passing its scrutiny, will go forward hall-marked for practical experiment or certain use. A clearing house for inventive ideas is not a new provision; but the advisory committee is more than that by reason of its constitution and its powers. It has the responsibility of sifting original ideas and inventions and the highest competence for the task, but it has no need to wait for ideas to reach it from outside. The committee itself is a kind of scientific power house from which great things may be expected.

The Times

TERMITES IN EAST AFRICA

III—FIELD KEY AND DISTRIBUTION (BY TERRITORIES)

By W. Victor Harris, M.Sc., A.I.C.T.A., F.R.E.S., Entomologist, Department of Agriculture, Tanganyika Territory

(*Received for publication* 16*th November*, 1940)

Since there are seventy-seven different species of termites already known to occur in East Africa, with quite a number more awaiting identification and, most likely, description as new species, and since there is exhibited among these a particularly wide range of habits, it is evident that something more precise in the way of names is necessary than lumping our observations together under the omnibus title of "termite". As an example, let us take the case of a timber ceiling which has collapsed as a result of attack by "white ants". In order to take the necessary precautions against the same fate overtaking the new ceiling, it is necessary to know what kind of termite was concerned, because a subterranean termite would have its nest in the ground and pass to and from the ceiling through earthen tubes constructed over or inside the walls; a so-called damp-wood termite would have a primary nest underground together with possible secondary nests in the woodwork or walls of the building, with intercommunicating tunnels; while a dry-wood termite would be self-contained within the ceiling itself, without the power to move through or over walls not made of wood, and not entering the building in the first case from the ground. As a further example, it is as well to ascertain that the present occupants of one of those large mounds are its original inhabitants, before going to the expense of destroying the colony with a view to preventing termite damage to surrounding grazing or to buildings in the vicinity. Colonies of large mound builders frequently die out and their building is taken over by one or more harmless species, the destruction of which would be a waste of time and money.

The classification of termites has been built up to a great extent on the size and shape of the head of the soldier caste. The workers are not specialized to the same extent and are not easy to distinguish. The winged reproductives are only found in the colony for a short time each year and their use in identifying the species is accordingly restricted. In a number of species the winged forms are unknown, while in others the free-flying adults have been given a name without their corresponding soldiers having been found. Owing to the great differences to be found among the various kinds of soldiers, they can by examination with a hand lens be allotted at least to their respective genera, and this is enough for most practical purposes.

The following key is intended to work only for the genera of termites already known to occur in East Africa, and has been simplified accordingly. The use of the adjectives "large" and "small" is not ideal, but their relative significance will become apparent after a few termites have been examined. It should be kept in mind that in some genera one species may have soldiers of two or more distinct sizes, which might erroneously be taken as belonging to two different species. Usually the major and minor soldiers are similar in most other respects than size.

The following terms employed may require explanation:—

Mandibles—Jaws, variously adapted for chewing, snapping, or, apparently, just ornament.

Labrum—The upper lip, a horny projecting flap between the mandibles, protecting the mouth.

Gulamentum—An area of the underside of the head, delimited by two grooves running from the vicinity of the mouth back to the neck.

Fontanelle—The opening of the frontal gland, found, when present, in the middle of the head just in front of or behind a line joining the bases of the antennae, according to the genus.

Pronotum—The shield or collar immediately behind the head.

Mesonotum and Metanotum—The second and third shields of the thorax respectively.

KEY TO SOLDIER TERMITES IN EAST AFRICA

1. Head drawn out in front to a long "nose"; mandibles minute and hidden away beneath head (Fig. 10, p. 65, this Journal, Oct. 1940) 2
   Head not drawn out in front; mandibles well developed and projecting in front of head .. 4
2. Head constricted behind the antennae—*Coarctotermes*.
   Head not constricted 3
3. Only one size of soldier in the Colony—*Eutermes*.
   Two or more sizes of soldiers present—*Trinervitermes*.

4. Eyes conspicuous black spots just behind the base of each antenna 5
Eyes not conspicuous 6
5. Head rounded; mandibles deeply toothed; large termites living in subterranean nests and foraging in full daylight—*Hodotermes* (Fig. 1)
Head rectangular; smaller termites living in timber and dead branches—*Calotermes* (Fig. 2)
6. Head without fontanelle; termites living entirely in timber or dead branches 7
Head with fontanelle; nests subterranean, or at least connected to ground by tunnels sometimes the fontanelle is difficult to establish, but the habit will be a sufficient guide) 8
7. Head longer than broad; mandibles long—*Neotermes*.
Head square, forehead steeply cut; mandibles short—*Cryptotermes*.
8. Pronotum flat and practically oval; fontanelle large and conspicuous 9
Pronotum saddle-shaped and divided up by grooves; fontanelle usually inconspicuous 10
9. Head pear-shaped, with large fontanelle on projecting forehead; mandibles without teeth; small pale yellow insect—*Coptotermes* (Fig. 4).
Head rounded but without projecting forehead; mandibles toothed; colour orange-yellow—*Schedorhinotermes* (Fig. 3).
10. Pronotum with two sharp projections on front edge 11
Pronotum without projections 12
11. Sides of meso- and metanotum drawn out into spines projecting backwards—*Acanthotermes*
Meso- and metanotum without spines—*Pseudacanthotermes* (Fig. 4, p. 64, this Journal, Oct. 1940.)
12. Labrum tongue-like, with blunt or pointed tip 13
Labrum rectangular or forked 21
13. Mandibles sabre-like, strong, dark coloured; medium to large termites with dark coloured heads 14
Mandibles not sabre-like, less robust; small termites mostly pale coloured 16
14. Mandibles without teeth on inner edges—*Bellicositermes* (Fig. 5).
Mandibles with teeth on one or both inner edges 15
15. Left mandible with a single simple tooth, right mandible smooth or with one tooth—*Termes* (Fig. 6).
Left mandible with serrated inner edge, right mandible with single tooth—*Allodontermes* (Fig. 7).
16. Mandibles long and straight with incurved tips 17
Mandibles shorter, curving from the base .. 18
17. Mandibles smooth; head rounded—*Microtermes* (Fig. 8).
Mandibles with inner edges finely serrated, head long rectangular—*Microcerotermes* (Fig. 9)
18. Mandibles strongly curved with sharp tooth on each inner edge—*Hamitermes* (Fig. 10).
Mandibles without a tooth 19
19. Labrum almost as long as the mandibles—*Labiotermes*.
Labrum much shorter than the mandibles .. 20
20. Labrum with bluntly pointed tip; mandibles smooth—*Ancistrotermes*.
Labrum with three-lobed tip; mandibles serrated—*Synacanthotermes*.
21. Labrum forked 22
Labrum not forked 24
22. Gulamentum with distinct projection—*Noditermes*.
Gulamentum smooth 23
23. Mandibles straight, with incurved tips—*Cubitermes* (Fig. 11).
Mandibles undulant—*Ophiotermes*.
24. Labrum with front edge concave—*Promirotermes*.
Labrum with front edge more or less squarely cut, with fine projections at corners—*Basidentitermes* (Fig. 12).

The termites already known to occur in East Africa are listed below, with an indication of the territory in which they are found. Records from Mafia are included in those from Tanganyika. Pemba and Fundu Islands are given under Zanzibar. Full use has been made of the localities recorded in Sjöstedt's *Revision der Termiten Afrikas* (1926). The writer's own collecting has been done mainly in Tanganyika with brief excursions to Uganda and Zanzibar. The assistance afforded by the Entomologists of the Uganda Department of Agriculture, with specimens both specially collected and from the reference collection, is acknowledged with appreciation.

A List of the Termites Recorded from Tanganyika, Kenya, Uganda and Zanzibar

	Tanganyika	Kenya	Uganda	Zanzibar
Hodotermes mossambicus Hagen, 1853	×	×		
Calotermes durbanensis Haviland, 1898	×			
C. jeannelanus Sjöstedt, 1915	×			
Cryptotermes havilandi Sjöstedt, 1897		×		
Neotermes firmus Sjöstedt, 1911		×		
N. athii Sjöstedt, 1915		×		
N. meruensis Sjostedt, 1907	×			
N. cryptops Sjostedt, 1899	×			
Schedorhinotermes lamanianus Sjöstedt, 1911	×	×		×
Coptotermes Sjostedti Holmgren, 1911	×			
C. amanii Sjöstedt, 1911	×			×
Acanthotermes acanthothorax Sjöstedt, 1898			×	
Pseudacanthotermes grandiceps Sjöstedt, 1915		×		
P. militaris Hagen, 1858	×	×	×	
P. spiniger Sjöstedt, 1899	×		×	
P. piceus Sjöstedt, 1911			×	
Bellicositermes bellicosus Smeathman, 1781	×	×	×	×
B. natalensis Haviland, 1898	×	×	×	
B. goliath Sjöstedt, 1899	×		×	
Termes monodon Gerstacker, 1891	×		×	×
T. amanicus Sjöstedt, 1925	×			
T. amaniensis Sjöstedt, 1924	×			
T. badius Haviland, 1898	×	×	×	
T. fallax Sjöstedt, 1924		×		
T. culturarum Sjöstedt, 1924	×		×	
T. terricola Sjöstedt, 1902				×
T. kibarensis Fuller, 1923			×	
T. tanganicus Sjöstedt, 1924	×	×		
T. stercorivorus Sjöstedt, 1907	×			
T. latericius Haviland, 1898	×		×	
T. microps Sjöstedt, 1899	×			
T. caffrariae Sjöstedt, 1897				×
T. ramulosus Sjöstedt, 1904	×			
T. aurora Sjöstedt, 1904				×
T. egregius Sjöstedt, 1925		×		
T. palmquisti Sjöstedt, 1907	×	×		
T. elgonensis Sjöstedt, 1926		×		
T. apollo Sjöstedt, 1905		×		
T. fulleri Emerson			×	
Allodontermes morogorensis Harris, 1936	×			

HEADS OF EAST AFRICAN TERMITE SOLDIERS

Not to scale; antennæ omitted.

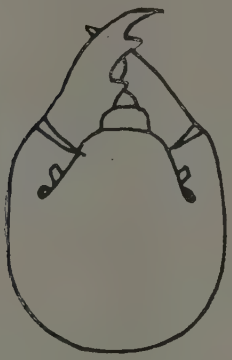

Fig. 1—Hodotermes

Fig. 2—Calotermes

Fig. 3—Schedorhinotermes

Fig. 4—Coptotermes

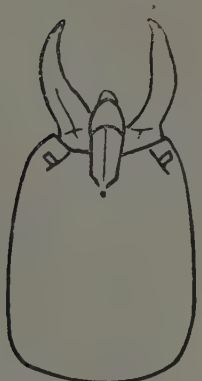

Fig. 5—Bellicositermes

Fig. 6—Termes

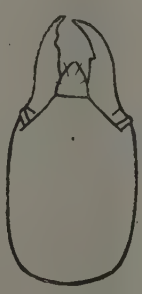

Fig. 7—Allodontermes

Fig. 8—Microtermes

Fig. 9—Microcerotermes

Fig. 10—Hamitermes

Fig. 11—Cubitermes

Fig. 12—Basidentitermes

A List of the Termites Recorded from Tanganyika, Kenya, Uganda and Zanzibar

	Tanganyika	Kenya	Uganda	Zanzibar
Labiotermes rhinoceros Sjöstedt, 1905			×	
Synacanthotermes zanzibarensis Sjöstedt, 1915				×
Ancistrotermes amphidon Sjöstedt, 1926			×	
Microtermes usambaricus Sjöstedt, 1925	×			
M. redenianus Sjöstedt, 1904	×			
M. vadschaggae Sjöstedt, 1907	×			
M. magnocellus Sjöstedt, 1915	×			
M. allaudanus Sjöstedt, 1915		×		
Hamitermes lonnbergianus Sjöstedt, 1911		×		
H. unidentatus Wasmann, 1897	×			×
H. meruensis Sjöstedt, 1911	×			
H. hastatus Haviland, 1898	×			
Microcerotermes parvus Haviland, 1898	×			
M. solidus Silvestri, 1912	×			
M. zuluensis Holmgren, 1913	×			×
M. parvulus Sjöstedt, 1911	×			
M. edentatus Wasmann, 1911	×			
Cubitermes bilobatus Haviland, 1898	×			
C. glebae Sjöstedt, 1913	×			
C. ugandensis Fuller, 1923			×	
Noditermes indoensis Sjöstedt, 1926	×			
Ophiotermes ugandensis Sjöstedt, 1925			×	
O. massaicus Sjöstedt, 1907	×			
Basidentitermes amicus Harris, 1936	×			
B. aurivillii Sjöstedt, 1897			×	
Promirotermes bellicosi Wasmann, 1912	×			
Eutermes maculiventris Sjöstedt, 1904				×
E. usambarensis Sjöstedt, 1904	×			
E. latifrons Sjöstedt, 1896	×			
E. kilimandjaricus Sjöstedt, 1907	×			
Trinervitermes segelli Sjöstedt, 1907	×			
T. gemellus Sjöstedt, 1902	×			
T. ruficeps Holmgren, 1913	×			
T. bettonianus Sjöstedt, 1905	×	×		
T. rapulum Sjöstedt, 1904	×			
T. gratiosus Sjöstedt, 1924	×			
Coarctotermes coarctatus Sjöstedt, 1902	×			

Nineteen genera are represented above out of a total of 62 occurring in the Ethiopian region, that is to say in Africa south of the Sahara. Of the 77 species listed, 11 are widely distributed throughout the Ethiopian region, 18 are found in the Congo and West Africa, 8 occur in Southern Africa, one occurs in Abyssinia, and the remaining 39 are restricted to East Africa.

The termites of the Ethiopian region are grouped into the following four families, each of which is represented in East Africa:—

Hodotermitidae, with a single representative, *Hodotermes mossambicus*, the harvester termite. This termite is found in the drier parts of South and South-West Africa, and up the eastern side as far as Abyssinia. It possesses functional eyes and is the only termite ordinarily to be met with moving about in bright sunlight. It makes a subterranean nest.

Calotermitidae—includes the three genera, *Calotermes, Neotermes,* and *Cryptotermes,* all"dry wood termites", boring in timber or the dried-out branches of trees. Colonies are made up of a few individuals as compared with those of the other families, and the nest is in the tunnels of the wood being attacked.

Rhinotermitidae—contains the two genera *Schedorhinotermes* and *Coptotermes,* "damp wood termites", found attacking old and wounded trees and the timberwork of huts and old buildings. There is a primary nest on or below ground level from which the termites move to their food-supply under cover of tubes constructed of chewed wood fragments. Secondary or colonial nests are also made in trees and buildings, and it is believed that these can in time maintain a separate existence, although some connexion with the ground is kept up.

Termitidae—the largest family of all, includes the mound builders, fungus growers and the guest termites. Nest type is a useful indication of genus in this family. *Bellicositermes* make the large conical or rounded "ant-hills" which are a feature of much of the East African savanna. *Termes* are mainly subterranean nest-builders, and include what is probably the commonest termite in East Africa, *Termes badius. Hamitermes, Microcerotermes, Cubitermes,* and the three genera with nasute soldiers, *Eutermes, Trinervitermes* and *Coarctotermes,* are responsible for the wide variety of small mounds common in upland grasslands, certain types of seasonal swamps and throughout the *Brachystegia* woodlands. The genera *Promirotermes, Ophiotermes* and *Basidentitermes* possess soldiers with long slender mandibles, apparently unfitted for useful work. They are found in the nests of other termites and are regarded as lodgers in abandoned sections of the nest or as tolerated guests.

There is no general agreement as to generic names among termites, and some confusion may arise, particularly from perusal of older

works on this topic. As an example of this, there is the large mound builder which Smeathman first described in 1781 as *Termes bellicosus.* In 1909 Holmgren put the African mound builders with smooth mandibles in a sub-genus *Macrotermes,* which Fuller in 1922 considered should be regarded as a genus separate from *Termes.* Next, Emerson in 1926 split this genus into two sub-genera, *Macrotermes* and *Bellicositermes,* the former exclusively West African. Finally, when Sjöstedt published his revision of African termites in 1926, he considered that *Bellicositermes* merited generic status, and there the matter stands for the time being. Another case is that of the use of *Nasutitermes* to embrace all the termites having nasute soldiers, and to abandon the older name *Eutermes,* to which has now been added *Trinervitermes* and *Coarctotermes.* A further tendency to embroider the scientific name with indications of sub-genus, sub-species and even variety is to make systematics cumbersome and unattractive to all who are not interested in it for its own sake. At the same time, a name is essential if observations are to be worth recording or if use is to be made of work done in other areas.

METHODS OF PLANTING WATTLE

The Forest Department, Kenya, sows treated seed direct in the land to be planted. Some farmers, however, transplant natural seedlings taken from under or near an existing plantation taken from under or near an existing plantation.

In April, 1937, an experiment was made in the Forest Department's plantations at Kikuyu to compare these two methods. As a matter of interest, wattle plants raised in wooden trays in the nursery were also put out for observation and comparison with the other two methods.

The plantings were made in rows nine feet apart, three rows to each treatment, and every treatment repeated seven times. Six months after planting the numbers of wattle plants growing were as follows, expressed as a percentage of the original number planted:—

Type of Planting	Percentage Survival at Six Months							
	Series No.							Mean of the 7 Series
	1	2	3	4	5	6	7	
								Per cent
Treated seed sown ..	94	89	87	84	88	79	89	87
Natural seedlings transplanted open-rooted	11	17	15	9	15	11	17	14
Nursery-raised transplants	75	86	75	67	56	65	72	71

The natural seedlings transplanted were 6 in. to 9 in. plants; they were planted with open roots. The nursery-raised transplants were 3 in. plants in shallow wooden trays, and were planted direct from the trays with soil adhering to their roots. The seed sown was treated according to the recommendation of the Forest Department's Research Bulletin No. 8 (viz. seed placed in a pot of boiling water which is immediately removed from the fire and allowed to stand for twelve hours cooling with the seed immersed; then spread out to dry).

During the six months after planting the natural seedlings transplanted grew hardly at all and, as shown above, many of them died. The sown seedlings and nursery transplants established themselves and started growing at a rapid rate.

Three years later the trees in the experiment were again examined. No further trees had died and their heights appeared to be about the same in the three treatments, except that wherever the nursery transplants came next to the sown seedlings they seemed to dominate them, being slightly taller and definitely more vigorous trees.

Conclusions.—A single sowing of properly treated seed will give an 80 to 90 per cent stand of young trees at six months old.

Transplanting open-rooted natural seedlings means many blanks to be filled in later, and they do not gain anything on the sown seedlings. Nursery transplants from trays do well, but they are not worth the extra cost of raising them in nurseries before the planting season.

Note 1.—The above refers to dry or moderate rainfall areas. In wet areas where weed growth is very vigorous it is probable that the use of nursery transplants will be well worth while.

Note 2.—A method of using natural seedlings which has been observed to be successful in the Limuru district (where rainfall and sites are good for wattle) is to dig up little groups of three to six natural 1 in. to 2 in. seedlings and to transplant the whole group, with soil intact, into the land to be planted. This is rather a tedious business, and is obviously only suitable for establishing at most an acre or two of plantation.

S. H. WIMBUSH

DANGEROUS GRASS

The passages here reproduced are extracted from an article with the above title, published in 1939 in a local farmers' monthly, by Dr. W. A. Albrecht, of the University of Missouri, U.S.A. The article describes cases of stock ailments resembling milk-fever, and of malformation of the skeleton, which occur on pastures of low fertility whose herbage has been shown to be deficient in the common plant-nutrient minerals. The author's argument is that the problem of restoring eroded lands is not solved merely by getting grass to grow upon them, if the state of impoverishment of the soil causes the grass to be of low feeding value. In such cases the soil must be fed by suitable fertilizer treatment, more especially by liming; otherwise the apparent success in establishing a grass cover is a delusion, and the grass is "dangerous".—ED.

Sick soils will not produce healthy plants. Sick plants will not nourish healthy animals. Sick animals will yield no income. What shall it profit us, then, if our frantic search for a foolproof grass to grow on abused soil is successful?

We have become conservation-conscious within recent years. We have come to recognize the threat to civilization from soil erosion. We have embraced the obvious solution, protective covering to heal the scars of wind and water, to hold the remaining surface and fertility.

But suppose we do succeed in getting the sick land back to grass? Suppose we find plants that will exist on it? They will hold the surface, which is desirable, but will they restore the land to useful production? Vegetation that will not support healthy animal life will not solve our problem.

Granting that a sod can be established, what kind will it be—sick or healthy? The query is not concerned with varieties, but with the nutritive content of herbage. Increasing cases of animal malnutrition, animal irregularities, animal diseases have been traced to feeds from the less fertile soils.

Occurrence of these ailments is closely associated with those soil types that are commonly irregular in crop production and which have been leached and exhausted of their basic nutrient elements to such a low content as would misnomer their ailment by the less informative term of "high degree of soil acidity".

Chemical studies have been made of soil and of vegetation it produced that ailing animals consumed. When chemical findings are related to animal case histories, they designate the seat of the trouble as the low level in the soil of the nutrients essential for plants and required in larger amounts by animals. On the more "sour" soils where lime has been badly needed, but was not applied, and where nutrients other than calcium run closely parallel with it in deficiency degree, the pasture herbage has scarcely the equivalent of wheat straw in its content of calcium or lime and phosphorus.

Analyses of herbage which had defaulted in its support of a cow showed a calcium content of but 0.27 per cent and a phosphorus content of only 0.08 per cent. Ordinary wheat straw has 0.21 per cent of calcium and 0.12 per cent of phosphorus.

Feeding herbage of such composition to cattle might well be classed as a case of gross deception. Giving them green pasturage but on a soil failing to stock it to the equivalent of even wheat straw in terms of the most dominant ash constituents needed by the cow, is like bringing on the spring season but feeding a winter ration. Too bad the animals can't prosecute under the law of mislabelled packages.

When the plant factory is running short of calcium, the lime content within the plant itself can be expected to be short. Likewise a good number of other items, such as possibly the vitamins, which are manufactured by the healthy plant, may be deficient. Fertilizing the soil is more than stuffing the plant with minerals. It is a case of balancing the plant diet for better results in the plant factory just as we try to balance the animal ration for better output by the meat or milk factory.

Remedying the plant ration by lime and phosphorus additions mainly to the soil will relieve us of remedying the animal ration in many cases, and will be much more simple than tinkering with animal physiology, which is infinitely complex.

A simple soil treatment, like liming, can do much for the animal's sake in term of higher content of minerals and protein in the forage portion of the ration.

SOME ASPECTS OF TESO AGRICULTURE

By J. M. Watson, B.A. (Cantab.), Dip. Agric. (Cantab.), Agricultural Officer, Uganda

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Teso district, lying in the Eastern Province of Uganda, between the districts of Lango to the north and Bugerere to the south, was formally constituted by Proclamation of July 11th, 1912, under the Uganda Order in Council of 1902. The district occupies an area of 4,052 square miles and according to the 1931 census the total population was 270,211.

Within the last year or so the district has been augmented by the addition of Kaberamaido county from Lango on the north and Bukedea county from Bugwere on the south. The writer however is not familiar with conditions in these counties and the present paper is confined to a discussion of the agricultural industry as it was prior to this readjustment of the district boundaries.

Topography, Vegetation, Climate

Two features of the landscape which strike the newcomer to Teso are firstly the rocky granitic outcrops which characterize so much of the district, particularly in the south in the county of Ngora, and secondly the almost interminable succession of swamps. This complicated network of swamps, permeating the whole area and draining eventually into Lakes Salisbury, Gedge and Kyoga, is connected with a markedly undulating topography, with an average altitude of 3,500 feet, although when viewed from the air the land appears excessively flat. However, the writer, who spent the first few weeks of his residence in Uganda riding a cycle around Teso, can vouch for the fact that a bird's-eye view is very deceptive. Many of the place names stress the hilly nature of the country, e.g. Kuju, on a slope; Kyere at a distance, a good view; Mukongoro, land above; Mukura, hills.

For a more detailed discussion of vegetation and soil fertility it is convenient to divide the district into four zones: the south-east zone occupied by Ngora, Kumi and part of Soroti and a small part of Usuku counties; the west zone embracing the whole of Serere county and part of Soroti county; the north and north-east zone comprising Amuria county and the greater portion of Usuku; and finally, the fourth zone, the lake shore areas.

In the counties of Kumi and Ngora (zone 1) the pressure of population and excessive cultivation have resulted in the reduction of the vegetative covering to an absolute minimum, while there is every indication of soil deterioration. Roscoe who journeyed from Soroti to Mbale in the early twenties and therefore traversed the area under discussion writes: "The Teso country . . . . is flat, with rocky hillocks dotted about, the grass is short and the few trees to be seen are stunted and yield poor timber. . . . . Owing to the dryness of the land wood is scarce and poor." This description is still accurate. There are a few tamarind and fig trees sparsely scattered about while the grass cover is thin, those grasses which indicate soil in good heart being absent. At Ngora market firewood ranks as one of the more important commodities.

It is interesting to note that the name Kumi is derived from the word *equmi,* a tree, a species of *Elaeodendron,* while Ngora means "few people". At the present time both names are somewhat of a misnomer.

The impoverished state of the soil which exists in these two counties can be ascribed to pressure of population over a long period of time and the consequent impossibility of providing an adequate resting period for the maintenance of fertility. The Rev. A. L. Kitching, who founded the important C.M.S. centre at Ngora in 1907, selected the site because it was where "the population is thickest, in a district where the number of inhabitants per square mile of area is probably larger than anywhere in the Protectorate except among the Bagishu". The possibility of utilizing farm yard manure to improve the tone and structure of the soil has been frequently mooted, but the difficulties of building covered kraals without an adequate supply of timber are considerable. Cob buildings may present a solution. The obstacle of providing a means of conveying the manure from the kraal to the field, particularly necessary when the fields are widely scattered, has not yet been satisfactorily overcome.

The second zone, i.e. Serere county and part of Soroti county, which is separated from Ngora and Kumi by the Agu channel connecting Lakes Salisbury and Gedge with Lake

Kyoga, presents a somewhat more prepossessing appearance. Everywhere there are indications of soil in good heart with a satisfactory vegetative covering. Among the more common trees are *Albizzia coriaria* (*Etekwa*), *A. Zygia* (*Ebata*), *Tamarindus indica* (*Epiduru*), *Combretum Gueinzii* (*Ekworo*), *C. Binderianum* (*Ekulonyi*), *C. ghasalense* (*Ekimeng*) and various species of figs. It is probable that some of the most fertile parts of Teso are to be found in this county. How long this will remain so is a matter of conjecture as already there is a definite migratory movement from the over-crowded counties of Ngora and Kumi to the more fertile districts in the west. Loewenthal has stressed the dangers of these uncontrolled migrations. Those who have had to leave their homes on account of soil deterioration do not migrate further than is absolutely imperative. There is then a well defined belt, yearly expanding, of overcrowding and over-cultivation along the edge of the area from which migration has become necessary. This belt has now extended well into Southern Usuku and Soroti and has undoubtedly obtained a foothold into the eastern part of Serere county.

Northern Teso (zone 3) is considerably less populated that the other counties which have come under review. Grasses, such as *Imperata cylindrica* and various *Hyparrhenia* species are generally abundant, while there is a satisfactory tree cover, *Butyrospermum* Parkii (*Ekungulu*), *Terminalia Spekei* (*Ekoboi*), various *Acacia* species (*Ekisim, Etiriri, Esuku*) being common. Towards the north and northeast, the rainfall decreases and this reduction is reflected in the gradual change from short-grass–tree savanna to the almost arid conditions of Karomoja. The agricultural development of Usuku and Amuria is retarded by the lack of water, particularly during the dry weather.

Finally mention must be made of the lake shore areas, which, owing to the elongated nature of the lake system, are fairly extensive. During the rainy season the water level of the lake and swamp rises considerably, for not only does Lake Salisbury receive the greater proportion of the run-off from Karomoja in the east but also the majority of the streams flowing down the northern slopes of Mount Elgon to the south. During the dry season however the water recedes, exposing a large acreage of valuable grazing land, one of the more valuable grasses therein being *Panicum repens*. Between these dry-weather pastures and the higher land there exists a belt of *Albizzia-Acacia* scrub developed on a poor easily eroded soil, particularly so in the vicinity of cattle paths and anthills. Though their soil may be thin and their crops poor, both in quality and quantity, the lake shore dwellers are compensated to a certain extent by a permanent water supply close at hand and a welcome addition to their diet in the form of fish, including catfish, *Clarias* sp., and lungfish, *Protopterus æthiopicus*.

The highest rainfall is experienced in the centre of the district in the neighbourhood of Soroti, the average fall there being some 55 inches. The remaining part of the district enjoys a rainfall between 55 and 50 inches, with the exception of Eastern Usuku, where it does not exceed 45 inches. Owing to the maldistribution of the rainfall, the annual figures tend to indicate a more satisfactory state of affairs than is actually the case. The dry season is normally from mid December to mid March. The rains usually break in mid March and ease off again from mid June to mid July. A second rainy period occurs in August, September and October.

The People

Numerically the Teso people are the second largest tribe in Uganda but, despite this, systematic and detailed knowledge of their traditional culture is very scanty. One reason is not far to seek. The language, related in structure to the semi-Hamitic dialects of the Nandi, Masai and possibly Bari, presents considerable difficulties to the European who is posted to the district for a short period only. The system of genders superimposed upon innumerable noun classes is sufficient to discourage the would-be learner, while the irregular formation of the plurals, frequently doubled, one for a limited number of individuals and one for the entire class, is but one of the many difficulties and irregularities that have to be overcome.

Before the development of the system of Native Administration chiefs, there appears to have been no central tribal authority, the tribe consisting of innumerable "kinship groups" (*atekerin*), each controlled by a senior member.

Regulations governing grazing rights, land usage, etc., were presumably settled at meetings of the "kinship group" leaders, but of the rules which guided their decisions, nothing is known.

Though of pastoral stock the Teso do not appear to have developed that inane attachment to cattle which characterizes so many of the semi-Hamitic peoples. Cattle, it is true, are still looked upon as a form of capital and the bride price is usually paid in kine, but there would appear to be a growing inclination to convert unwanted animals into cash, as the figures of sales at recent district cattle markets fully demonstrate.

	Cattle sold	Maximum price	Minimum price	Average price	Total
		Sh.	*Sh.*	*Sh. cts.*	*Sh.*
1937..	5,314	142	8	43 00	229,733
1938..	15,695	190	5	41 15	655,924
1939..	19,444	160	5	30 46	592,145

(The above figures were kindly supplied by the Veterinary Department.)

Land Tenure

The system of land tenure appears to be based on the principle that every individual has a right to obtain land and to keep it for his individual benefit provided he makes use of it. Every cultivator enjoys complete security of tenure of the land he is actually cultivating, although such security terminates when the land is finally abandoned owing to the gradual reduction of fertility. When new land is required, he obtains it by mutual consent of his neighbours and possibly the leader of the kinship group to which he belongs.

On behalf of agricultural students farming for the first time, the writer has frequently endeavoured to lay out small-holdings, including areas of resting land which, incorporated into a rotational system, were to be opened up in the distant future. This practice invariably led to unpleasantness between the smallholders and their neighbours who were unable to understand the necessity of reserving, for the exclusive use of certain individuals, land of which they were, in the immediate future, unable to make use.

In regard to the grazing of cattle which are for the most part herded and kraaled on a communal basis, there appears to be little or no control. Should cattle trespass on cultivated land, the owner of the land has the right to claim compensation from the owner of the cattle.

The establishment of the cotton industry and the introduction of ploughing both paved the way for radical changes in the political, agricultural and economic life of the Teso and it is of interest to examine these two factors in greater detail.

The Cotton Industry

The story of the growth of the cotton industry is soon told. In 1910 a few test plots of Egyptian cotton were established, while in the 1912–1913 season some 3,000 tons of seed cotton were produced from 14,098 acres, sown to two American Upland varieties (in Serere county, Sunflower, the rest of Teso, Allen). The first ginnery was erected at Bugondo by the British East Africa Corporation in 1912.

In 1917 48,000 acres were planted, producing 2,867 tons of seed cotton, and it was then confidently thought that the limit of cotton cultivation had been reached. But by 1938 this acreage had expanded to 126,312, producing 18,261 tons of seed cotton. The average yield of some 315 lb. seed cotton per acre that season, compared with many cotton producing countries, is low. This is partly due to the poor rainfall distribution, a high precipitation during the growing season being associated with an increase in Blackarm disease and a consequent reduction of the crop. The standard of cultivation still leaves much to be desired and an improvement in this respect would undoubtedly be followed by a substantial increase in yield, much more so than by a change in the type of cotton. Some of the chief faults of the cultivator are:—(i) Bad spacing, invariably too wide. Spacing trials over a series of years have demonstrated the value of a spacing 3 ft. × 1 ft. (ii) Planting too late. The optimum sowing date falls between the middle of May and the middle of June, with the exception of Usuku county where the optimum date is a month earlier. (iii) Failure to fill blanks after the first sowing. This is particularly important where the spacing is too wide. (iv) Planting to cotton more land than can be conveniently weeded and harvested. This is chiefly due to the misuse of the plough.

Most of the rotations adopted by the Teso cultivator are based on the cotton crop. Invariably the first crop after fallow is cotton, planted in June. In the following January, *Eleusine coracana* (finger millet) is broadcast into the standing cotton and then, when the latter is uprooted and burnt in March, the millet is left in possession of the field. After harvesting the millet, the land is not infrequently sown to a further cotton crop or else to a food crop such as sweet potatoes, sorghum or, very frequently, cowpea. Pressure of population on the land controls the length of the fallow period; in Ngora this is reckoned in months rather than years, while excessive grazing of the land during this recuperative

period neutralizes any beneficial effect of the fallow. Where population is not so dense, the fallow period may extend from three to six years.

Ploughing

The growth of the cotton industry and the phenomenal increase in ploughing are complementary; the one was impossible without the other. The high price paid for cotton prior to, and during, the last war, encouraged its production, while the use of the plough enabled the individual cultivator to put under cotton the maximum acreage with the minimum amount of labour.

Before the introduction of the iron hoe, the Teso scratched the ground with a simple wooden spade provided with a handle some three feet in length (*akuta*). The writer has never had an opportunity of inspecting this implement, but understands it is still to be seen occasionally in use in the southern parts of Usuku. The iron hoe, despite its cost when first introduced (Rs. 1/75 to 2/50 in 1918), soon displaced the wooden spade and now, in conjunction with the plough, is the universal agent of cultivation. It is interesting to note that in 1918 an attempt was made to make hoes locally and a party of Bunyoro smiths were introduced to instruct the Teso in the art of their manufacture. However as no suitable ore could be found, the smiths returned to Bunyoro without accomplishing anything.

At the end of 1913 there were about 48 ploughs in the district. They were popular with the chiefs but owing to the difficulty of procuring spare parts their extended use was retarded. By 1918 the supply was unable to satisfy the demand, while a hundred were sold in 1919. In 1920 the Reverend Syson of the C.M.S., Ngora, became an agent for Messrs. Ransomes, Sims and Jefferies, and happily blending Christianity with commerce, was largely responsible for popularizing the type of plough which is in common use to-day, i.e. Ransome's E.C.A. plough. He also devoted much time to valuable instruction in the use of the plough at the agricultural school attached to the mission.

By 1932 there were 8,280 ploughs in the district, while in 1939 there was the phenomenal total of 19,894. So popular has ploughing now become that a cultivator who does not possess a plough will willingly hire for 2/- per day a plough and team of four oxen from a more fortunate neighbour.

The present standard of ploughing, though still poor, is improving, largely on account of the better training of oxen. No attempt however is made to adjust the plough to suit different sets of circumstances. Invariably the hake and drawbar are removed and the trek chain attached to the end of the beam. This is tantamount to setting the plough to work at its maximum depth, which is generally undesirable, and in order to reduce the depth of ploughing the ploughman utilizes the wheel to control the set of the plough, lowering it so as to prevent the share entering to its maximum extent. Under such circumstances it is hardly to be wondered at that the standard of ploughing is low!

The misuse of the plough has in the past resulted in considerable damage to the soil, where the formation of gullies has followed ploughing up and down the slope. Plough owners are still too inclined to open up more land than they can conveniently manage; they fail to appreciate that one plot well cultivated is worth two badly tilled and left unweeded.

In 1919 an attempt was made to introduce "vertical co-operation" by a company which proposed to tractor-plough large acreages of land on which peasants were to be encouraged to grow their cotton, the growers receiving a proportion of the profits from the sale of the crop. Roscoe visiting Teso in 1920 records that he came across a cotton field "several miles long". It is to be hoped that the promoters of the scheme were aware of the dangers of soil wash following ploughing up and down the slope.

Food Crops

The chief food crop is finger millet, which provides the flour from which the staple food, *atap* (a thick type of porridge), is made. The grain is ground between stones to a fine degree and then slowly added to boiling water until the right consistency is reached. The water is sometimes flavoured with the crushed fruits of *Ximenia americana* (*Elamai*) or *Tamarindus indica* (*Epeduru*), while buttermilk is also used as a medium in which to cook the porridge.

The usual method of planting the millet has already been described. At harvest time the heads are cut off with a knife and the grain is stored in the head until required. Many types of millet are planted, one of the favourite being *Emoiti*, an early maturing type which produces good quality flour and makes excellent "strong" beer. There is a general belief that under certain circumstances a field of *E. coracana* will revert to *Ekitu* (*E. indica*), and some types of millet are said to undergo this change more freely than others.

Agricultural classes under the writer's charge at Serere, the Government Experimental Farm, have attempted to bring about this reversion artificially but with no success, although a field sown to millet on a model holding bore an excellent *Ekitu* crop, while a similar distressing result was experienced by the botanist at the same station, on the hallowed ground of a breeding plot.

Sorghum, particularly important in the manufacture of beer, is generally planted as a second rain crop, the land being ploughed, the seed broadcast and hoed in. Many varieties are recognized, the harder grained types being prized for flour while the softer grained and sweet varieties are more commonly used for beer. These latter are more freely attacked by birds.

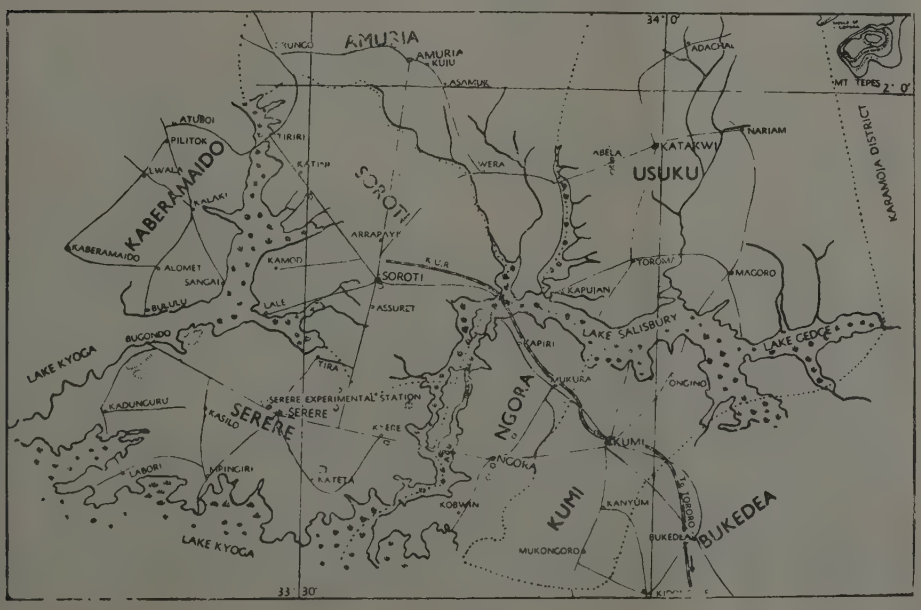
Cowpea is almost invariably planted after the millet crop, the land being ploughed and the seed hoed in. The peas are eaten in the form of a porridge, not infrequently augmented with sim-sim and groundnuts. The leaves (*Eboo*), when boiled and pounded, provide a palatable vegetable dish.

Sweet potatoes also form an important item of diet, either in the fresh form or dried for flour. They are planted whenever rainfall permits, on mounds, three to four slips per mound being general. A favourite type, *Emadarit*, is a high-yielding variety with large purple-edged palmate leaves and red sweet-flavoured tubers. *Endebedebe*, another popular type with small light-green leaves and white tubers, is favoured for its early maturing.

The present types of cassava, both short- and long-term, are introductions from Buganda. The original Teso cassavas are reported to have been of low quality, their consumption frequently being associated with internal complaints. The crop is recognized as an important stand-by in time of famine and its planting on a communal basis is given every encouragement. Mosaic disease results in much reduction of yield and selections of types resistant to the disease have been made. These however are not always acceptable from a culinary point of view, while a resistant type producing a high yield of good "sweet" tubers in South Teso may yield quite the reverse in the North.

Groundnuts and sim-sim are grown to a large extent, considerable quantities of both being sold for export when prices are sufficiently attractive to the producer. Groundnuts thrive well on the lighter sandy soils in the East of the District and are frequently planted as a first crop after the fallow, the seed being broadcast on the newly turned furrow and afterwards hoed in.

MAP OF TESO DISTRICT



Both groundnuts and sim-sim are prepared for consumption by pounding in a special pestle and mortar (the *ekisu* and *arukit*), after being slightly damped and dried over a fire. The addition of cooked vegetables, including cow-peas, to the pounded mass is not infrequent.

Vegetables are thoroughly cooked before consumption, a special hammer shaped instrument (*eipiret*) being employed to stir and pound the leaves in the process of cooking. There are innumerable wild plants used as such, among the more common being *Ejattoto* (*Asystasia Schimperi*), *Ekeliyo* (*Celosia argentea*), *Echaboi* (*Gynandropsis gynandra*), *Egwanyira* (*Hibiscus cannabinus*), *Emalakwang* (*Hibiscus Sabdariffa*) *and Ekilitoni* (*Sonchus Bipontini*). Some common relishes are *Alitot* (*Corchorus trilocularis*), *Ekoropot* (*Aneilema beniniense*) and *Emorosi* (*Cissus adenocaulis*). During famine, such as occurred in 1918, the roots of water lilies were gathered and eaten.

The ash of various plants is used in lieu of salt, among which are *Asteracantha longifolia, Vernonia Grantii, Lippia adoensis, Asystasia gangetica, Ageratum conyzoides, Aspilia kotschyi, Laggera alata* and many others, including various sedges.

The Teso granary is a rough structure made of bands of grass (*Trichopteryx* sp.) embedded in mud superimposed in coils one upon another so as to form an enormous kind of jar some four to five feet high, the whole structure being mounted on stones and provided with a grass roof. The constant lifting of the lid tends to wear away the brittle sides of the store, thereby gradually reducing its height until finally there is nothing left but the lid and the foundations.

Concluding Remarks

A local wag once remarked that, although the Teso cotton crop was large, the crop of agricultural perplexities which germinated in its wake was still larger. This indeed is no overstatement of the case, for the rapid change from primitive subsistence agriculture to the primary production of cotton and other crops of world economic importance has not been achieved without considerable disruption of the whole economic and social framework of the Teso people. The inevitable result of such an upheaval, soil deterioration, is only too well known to the tropical agriculturalist, and the district of Teso provides no exception to this immutable law. No single factor is responsible for this state of affairs however, but an insidious combination of factors inescapably linked together, chief among which are: insufficient resting period after cultivation, injudicious grazing, unskilled ploughing, deforestation, mal-distribution of stock and unco-ordinated burning of grass and bush.

A plethora of schemes and suggestions has been advanced to deal with these problems and already considerable progress has been made in putting a stop to the rape of the Teso earth. Among the methods now being actively adopted are the alienation of steep hills for reafforestation purposes, the construction, on a large scale, of narrow-base graded bunds, the improvement of water supplies by the construction of dams, the encouragement of the system of strip cropping in selected areas and an experimental re-settlement scheme. Finally, mention must be made of the Teso Climatic Belt, comprising an alienated strip of territory some ten miles in width, on the northern and eastern boundaries of the district. With this it is hoped to stay the ever encroaching Sahara Desert with all its accompanying evils of sheiks, camels, the Foreign Legion and the inevitable dry nullah.

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PASTURES AND GRASSES ON THE SERERE EXPERIMENT STATION, UGANDA

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Introduction

Since the year 1934 when it was decided to change the existing rotation,[1] which entailed continuous cropping interspersed with green manures, for a rotation which allowed the land to rest for three or four years under planted grass after only two years of cultivation, our attention has been focused more and more on the study of the indigenous grasses. We were forced to conclude that we could not keep up the fertility of our light and easily eroded soils unless we made provision for the recovery of the soil structure. It was thought at first that *Panicum maximum* would prove to be the most suitable grass for this purpose, since it is very palatable to cattle and it was intended to graze the resting arable land to some extent. It soon became apparent that a tufted grass of this description was not suitable, as a complete cover was not obtained and the soil between the tufts was subjected to excessive trampling and in consequence erosion occurred between the tufts. The next attempt consisted in establishing a mixture of *Panicum maximum* and the creeping *Cynodon plectostachyum*. This gave more promising results but was not a complete success as it was found that the cattle overgrazed the *Panicum* and left the *Cynodon* alone until the latter became coarse and unpalatable; in the meantime the *Panicum* could not compete with the ungrazed *Cynodon*.

To-day we are of the opinion that the most suitable carpet grass for the basis of temporary leys under Serere conditions is *Brachiaria decumbens*. This grass is very palatable and forms a deep and dense mat of vegetation if left ungrazed; if it is heavily grazed it forms a tight close carpet over the soil. During a prolonged dry season it becomes rather brown and the bulk decreases. For this reason we are trying to obtain another grass, more drought-resistant than the *Brachiaria*, which will grow readily in association with it and so increase the bulk of fodder during the dry season. We are of the opinion that it is undesirable to plant a pasture with only one grass, and we are experimenting with a large number of possible combinations of grasses in the hope that we shall eventually obtain a satisfactory mixed pasture.

It should be understood that we have very little information as to the behaviour of our more promising grasses when in association with properly inoculated procumbent legumes. One of us (H.R.H) during a recent visit to the United States of America was very much impressed by the superiority of grass–legume pasture mixtures over grass alone at certain Experiment Stations. In the mixed pastures the drought resistance of the grasses is noticeably increased by the legume, and the general health, and hence growth rate, of the grasses is much improved. It is our intention to try to obtain a suitable procumbent legume which will grow in association with *Bracharia decumbens* and *Chloris gayana*.

These notes contain a description of the work which has been done at Serere on grasses, together with our observations and tentative conclusions. Much of this work has been done in addition to the routine duties of the officers concerned and for this reason it is not as extensive as we could have wished. Our observations may however prove to be of some value to others interested in this very important and interesting subject.

Establishment of Pastures from Seed

The collection of viable seed of some grasses presents certain difficulties. For example *Panicum maximum* shatters very soon after the seed is set and for this reason natives collect heads which are bearing only empty glumes. If the heads are collected attached to the straw and while still green, viable seed in considerable quantities can readily be obtained provided care is taken to ensure that seed has set. Other grasses such as *Chloris gayana* and *Hyparrhenia* species present little difficulty in this respect.

Under the rotation now in operation we are forced to sow the grass after the food crops have been harvested in August. This leaves only a short period of wet weather before the onset of the dry season, and cer-

[1] See this Journal, Vol. 4, p. 116.—*Ed.*

tain grasses are unable to germinate and become established. *Chloris gayana* for example seldom germinates or establishes itself in the same year if planted in September, but the seed remains dormant in the soil until the break of the rains in the following April. Thus the soil remains with only a weed cover during the dry season from January to the beginning of April.

The following grasses have been grown from seed at Serere:—(1) *Aristida adscensionis* var. *guineensis*, (2) *Brachiaria brizantha*, (3) *Brachiaria comata*, (4) *Brachiaria fulva*, (5) *Brachiaria kotschyana*, (6) *Brachiaria platynota*, (7) *Chloris gayana*, (8) *Cynodon dactylon*, (9) *Cynodon plectostachyum*, (10) *Digitaria ternata*, (11) *Eleusine indica*, (12) *Eragrostis* (many species), (13) *Hyparrhenia cymbaria*, (14) *Hyparrhenia filipendula*, (15) *Hyparrhenia rufa*, (16) *Panicum maximum*, (17) *Paspalum commersonii*, (18) *Pennisetum polystachyon*, (19) *Pennisetum purpureum*, (20) *Beckeropsis* near *uniseta*, (21) *Perotis indica*, (22) *Rhynchelytum repens*, (23) *Sorghum verticilliflorum*, (24) *Urochloa panicoides*.

Although *Brachiaria decumbens* does not seed readily at Serere if grazed, the seed is viable.

The Natural Succession on Abandoned Arable Land

The following observations were made on two adjoining plots which had been under cultivation for two years.

Plot A.—Under food crops (millet, etc.) in 1936, following cotton in the previous season. In August 1936 this plot was left to regenerate naturally.

In March 1937 a transect through the plot showed the following grasses and their proportions:—

	Per cent
Digitaria velutina	56
Rhynchelytrum repens ..	14
Panicum atrosanguineum ..	6

By August 1937 the total grass population had decreased by 42 per cent because of the complete disappearance of the *Digitaria* and a marked reduction in the number of the other ephemerals. At this time the following grasses were also to be found in the plot:—*Paspalum commersonii, Perotis indica, Brachiaria kotschyana, Pennisetum polystachyon, Imperata arundinacea* var. *thunbergii, Rhynchelytrum repens* (in small quantities).

Plot B.—Under food crops in 1935, following cotton in the previous season. Planted with *Stizolobium Deeringianum* in August 1935. In March 1937 a transect through the plot showed the following grasses and their proportions:—

	Per cent
Rhynchelytrum repens ..	27
Imperata arundinacea var. *thunbergii*	27
Paspalum commersonii ..	10
Setaria sphacelata	7

It should be noted that the *Stizolobium* was not weeded during the period August 1935 to March 1937.

In addition to the above grasses small quantities of the following were also present in March 1937:—*Chloris pycnothrix, Digitaria velutina, Brachiaria kotschyana, Pennisetum polystachyon, Cynodon* spp., *Sporobolus pyramidalis, Perotis indica, Beckeropsis uniseta, Eragrostis tenuifolia, Brachiaria fulva, Brachiaria brizantha.*

By August 1937 the grass population had increased by 152 per cent mainly because of the rapid increase of *Pennisetum polystachyon* and *Rhynchelytrum repens. Brachiaria Kotschyana* and *Perotis indica* had increased, though not to the same extent as the *Pennisetum* and *Rhynchelytrum*. The remaining grasses were in about the same proportions as in the previous March.

The effect of *Stizolobium Deeringianum* as a nurse crop for the natural regeneration of the indigenous grasses is thus indicated. Not only does it appear to result in a much denser grass population but also in a greater range of species.

The end point of the grass succession is determined by the soil type. In general the deeper soils at Serere result in a pure stand of *Imperata cylindrica* and the shallow soils overlying ironstone or murram gravel a pure stand of *Hyparrhenia* species.

The Succession in Seeded Pastures Grazed by Cattle

Some interesting results have been obtained from two one-acre paddocks on the smallholdings at Serere. The two paddocks were fenced in August 1936 and the following mixture was sown[1] on each:—

Paspalum commersonii ..	5 lb. per acre
Urochloa panicoides ..	6 lb. ,,
Panicum maximum ..	3 lb. ,,
Chloris gayana	5 lb. ,,
Setaria sphacelata ..	5 lb. ,,
Total grass seeds ..	24 lb. ,,

[1] Planted by E. Williams, Agricultural Officer, Education.

In addition to the above grasses 1½ lb. of slips of *Indigofera endecaphylla* were planted in each acre paddock.

Paddock No. 1 has been heavily overgrazed since the pasture became capable of supporting cattle, while No. 2 was grazed to its full capacity until 1938 without damaging the grass stand to any noticeable extent.

Grass counts were made at intervals[1] in square metre quadrats, and gave the following results:—

Species Population as Percentage of the Total Grasses

	No. 1 Over grazed			
	Jan., 1937	Aug., 1937	April, 1938	April, 1939
Paspalum commersonii ..	53	25	19	0
Urochloa penicoides ..	0	0	0	0
Panicum maximum ..	2	22	0	0
Chloris gayana	0	0	0	0
Setaria sphacelata ..	0	2	7	8
Sporobolus pyramidalis ..	2	20	73	32
Imperata cylindrica ..	0	0	0	0
Hyparrhenia spp. ..	0	0	0	0
Eragrostis spp.	2	0	0	0
Unidentified grass spp. ..	41	31	1	60
Indigofera sp.	0	0	0	0
Total grasses per quadrat	53	83	26	38

	No. 2. Well Grazed			
	Jan., 1937	Aug., 1937	April, 1938	April, 1939
Paspalum commersonii ..	76	13	31	0
Urochloa panicoides ..	0	3	0	0
Panicum maximum ..	14	31	0	2
Chloris gayana	0	12	4	3
Setaria sphacelata ..	0	0	0	0
Sporobolus pyramidalis ..	0	13	31	10
Imperata cylindrica ..	0	0	12	2
Hyparrhenia spp. ..	0	1	4	10
Eragrostis spp.	0	0	4	0
Unidentified grass spp. ..	10	27	12	73
Indigofera sp.	0	0	2	0
Total grasses per quadrat	37	89	52	52

The last count in April 1939 contained a large number of very young grass plants which were impossible to identify.

It will be noticed that the overgrazed paddock contained a much larger population of *Sporobolus pyramidalis* and *Setaria sphacelata* than the well-grazed paddock. This observation has confirmed the opinion that overgrazing under Serere conditions results in the rapid increase of the unpalatable *Sporobolus*.

The results also point to the difficulty of establishing a good mixed pasture from seed when the sowing is done in the second half of the year. (Compare the composition in April 1938 with the mixture sown.) Also it will be noted that the well-grazed paddock had approximately twice the number of grasses per quadrat as compared with a similar area in the overgrazed paddock. Between April 1938 and April 1939 the overgrazed paddock was more lightly grazed than in the period prior to April 1938 and this will explain the relative increase in the number of grasses in the overgrazed paddock during the first mentioned period.

The behaviour of *Chloris gayana* in Paddock No. 2 was unexpected. It was thought that this grass would persist after it had become established. It is unfortunate that it never germinated in Paddock No. 1. The complete disappearance of *Panicum maximum* in both paddocks in April 1938 was another unexpected result. It must be presumed that even Paddock No. 2 was grazed excessively since there is some sign of recovery in this paddock in April 1939.

The behaviour of *Urochloa panicoides* followed expectation. It is known that this grass rarely persists except along paths. It is an early invader of all abandoned arable land, but it never persists for any length of time.

The appearance of *Imperata cylindrica* in Paddock No. 2 points to this paddock having better and deeper soil than Paddock No. 1.

Grazing records were kept for both paddocks, but they are not considered to be very reliable since the cattle have to go a considerable distance for water. For the period January 1937 to December 1937 inclusive Paddock No. 1 supplied a total of 2,388 ox-grazing hours and No. 2 2,048 ox-grazing hours. It is concluded that No. 1 would have maintained one ox from February to the middle of June, after which some swamp grazing would have been necessary. This paddock could have been opened again for the whole of August and part of September, but for the remainder of the year the greater part of the time would have to be spent grazing elsewhere.

From the middle of May 1938 to the middle of January 1939 Paddock No. 1 supplied 5,943 ox-grazing hours. This paddock has supplied a total of 8,331 ox-grazing hours for the period January 1937 to January 1939.

[1] Observations by J. M. Watson, Agricultural Officer, Education.

Assuming that one ox grazes eight hours a day this paddock has supported the equivalent of 1.37 oxen per acre for 25 months.

Paddock No. 2 was closed throughout the year 1938.

The last grass counts quoted above do not give a true picture of the appearance of the two paddocks. In April 1939 No. 1 showed obvious signs of acute overgrazing, while No. 2 has a good cover, although most of the grasses have grown away from the cattle during its year of rest.

Compatability of Different Grasses Grown Together

In 1937 a series of small plots were put down, each with two species of grass in alternating rows. The aim was to determine which grasses will grow successfully in close association with one another. One half of each plot was heavily grazed while the other half was allowed to grow with no outside interference. The series were divided into two groups:—

(i) Mixtures of two carpet grasses.

(ii) Mixtures of a carpet grass with a tufted grass.

Observations have been made on these plots from time to time, but the last set of observations made in April 1939 after a very long dry season are probably the most interesting. It at once becomes obvious that the most successful grass is *Brachiaria decumbens* both on its merits alone and in mixture with certain other grasses.

Group (i).—*Brachiaria decumbens* mixed with *Cynodon plectostachyum* gives a well balanced mixture with neither species predominating and a very fair cover. The *Cynodon* is inclined to grow too hard for it to be grazed and it is probable that in time the *Brachiaria* will decrease as it is grazed more heavily than the *Cynodon*.

Brachiaria decumbens mixed with *Cymbopogon excavatus*[1] is not a particularly successful mixture. A very good cover is formed almost entirely by the *Brachiaria* while the *Cymbopogon* although very drought resistant and unpalatable does not compete well against the former grass.

Brachiaria decumbens mixed with *Paspalum notatum* gives a very good cover with the *Brachiaria* slightly predominant. The *Paspalum* is slower to cover after the prolonged dry season.

Brachiaria decumbens mixed with *Paspalum commersonii* shows almost a pure stand of the *Brachiaria* after the dry season. This *Paspalum* is an annual and seeds very freely and it is possible that after the break of the rains a certain amount of seed will germinate.

Of the above four mixtures of carpet grasses the most successful is undoubtedly *Brachiaria decumbens* with *Paspalum notatum*.

Group (ii).—This series of plots consisted of a mixture of *Brachiaria decumbens* with various tufted grasses.

The tufted grasses used were—*Panicum maximum, Chloris gayana* (not a tufted grass in the true sense of the term), *Pennisetum polystachyon, Hyparrhenia rufa* and *Hyparrhenia filipendula*. Of these, both *Pennisetum polystachyon* and *Hyparrhenia filipendula* have failed to persist and the plots are a pure stand of *Brachiaria decumbens*. *Panicum maximum* has persisted well and a very fair cover has been formed.

The mixture with *Chloris gayana* is very weedy and the *Chloris* has not come away as well as one would have expected. A very fair cover has formed but the appearance will probably improve after the break of the rains.

Hyparrhenia rufa has grown strongly but is much too woody for the cattle to graze it down; to make it palatable it has to be slashed at regular intervals. The *Brachiaria* has formed a good cover but the mixture is not a success.

While not as successful as the mixtures of two carpet grasses the mixtures of *Brachiaria decumbens* with *Panicum maximum* and *Chloris gayana* are worth further trial.

Of the remaining mixtures the only ones which show any promise are—*Paspalum notatum* with *Panicum maximum*, and *Paspalum notatum* with *Hyparrhenia rufa*. The former is the better of the two as both grasses are persisting well and a good bulk of grazing material will form after the break of the rains. In the latter mixture the *Hyparrhenia* is again very woody and will require frequent slashing.

[1] As a rule in East Africa this species cannot be called a mat grass, but tends to form tussocks. The strain used at Serere is stated, however, "when grown in a pure stand" to become "a thick mat with no tendency at all to tussocks".—*Ed.*

Palatability

Careful observations have been made on the preference of cattle for a large number of grasses. The following list gives the order of palatability[1]:—

Group 1.—*Panicum maximum, Brachiaria brizantha, Brachiaria decumbens, Brachiaria fulva, Brachiaria platynota, Chloris gayana* (local strain).

Group 2.—Eaten in the young stage only: *Hyparrhenia filipendula, Pennisetum purpureum, Pennisetum polystachyon, Paspalum commersonii.*

Group 3.—Eaten in the young stage only: *Hyparrhenia rufa, Hyparrhenia cymbaria, Setaria sphacelata, Beckeropsis uniseta, Eragrostis superba.*

Group 4.—Eaten only when the grasses listed in Groups 1 to 3 were completely finished: *Chloris pycnothrix, Digitaria ternata, Eragrostis spp.* other than *E. superba, Loudetia arundinacea, Loudetia simplex, Perotis indica, Rhynchelytrum repens, Rottboellia exaltata, Sporobolus pyramidalis, Urochloa panicoides.*

Group 5.—*Cenchrus ciliaris* (from Kenya), *Paspalum notatum* (from Kampala), *Cynodon plectostachyum, Cymbopogon excavatus.*

Two groups of cattle were used to obtain the above order of preference. It was noticeable that the local Teso cattle objected to hairy grasses and for this reason did not like the *Pennisetum purpureum* obtained from the Scott Laboratory, Nairobi. Ankole cattle on the other hand did not discriminate against hairy grasses and for this reason grazed the Kenya *Pennisetum purpureum* readily. It should be noted that palatability when judged in this manner is determined largely by the grasses to which the cattle have been accustomed, and also by the stage of growth of certain of the grasses. For example when *Cymbopogon citratus* was first introduced to Serere some years ago the cattle left it severely alone, but to-day they eat it readily. It is possible that they could be accustomed to *Cymbopogon excavatus* which appears at the bottom of the palatability list. This is an extremely desirable grass as it has a good habit, it is extremely drought-resistant and recovers very rapidly after being burnt. *Cynodon plectostachyum* will be grazed readily if it is young and green. We are of the opinion that if this grass is used for permanent paddocks it should receive a shallow ploughing at regular intervals to bury the long dry hard runners which the cattle will not touch. *Brachiaria platynota* which appears in Group 1 of the palatability list does not persist. This may be due to the cattle eating both stems and leaves with avidity.

The Management of Pastures and Control of Grazing

In our experience we have found that it is difficult to keep a pasture in good condition for grazing if it contains a high proportion of tufted grasses. After periods of intensive grazing and while the self-sown seeds are germinating in the rains following the dry season the pasture has to be rested and the tufted grasses immediately shoot and flower; the cattle are then unable to eat off the long hard straw. To keep the pasture in condition and to prevent the more undesirable tufted grasses from seeding it is necessary to slash or even to cut the paddock with an ox-mower.

On the other hand, if carpet grasses such as *Brachiaria decumbens, Cynodon plectostachyum, Paspalum notatum* or the creeping semi-erect *Chloris gayana* are used then it is not difficult to keep the pasture in good order and it will not be necessary to resort to mowing. An occasional weeding of the pasture, however, will nearly always repay itself.

The grasses mentioned in the preceding paragraph will stand very heavy grazing during the rainy months, and if the grazing has been done carefully will supply a considerable bulk even during the dry season. With tufted grasses, on the other hand, it is almost impossible to ensure a good supply of grazing during the dry months, and supplementary grazing in the swamps will be required.

We would like to emphasize that the majority of the indigenous grasses in the area surrounding Serere are quite unsuited for intensive grazing, either by reason of their habit and low palatability or because of the proportions in which they occur in natural grassland. For the greater part of the year the predominant *Hyparrhenia* species and *Imperata cylindrica* are quite uneatable. It is for this reason that the native stockowner who practises range grazing has to burn off the grass during the dry season. There is no doubt that he would procure better pasturage

[1] The authors explain that this is based on "the independent observation of several observers, both African and European, on the behaviour of the cattle when grazed on the area containing the plots."—*Ed.*

if he burnt off the grass before the onset of the dry weather. Under range grazing conditions, and with the indigenous grasses, burning each year is a necessity. If on the other hand intensive controlled grazing is practised on planted pastures, burning need not be resorted to for these reasons; but intensive controlled grazing of course necessitates the use of fencing.

So far we have not tested the effect of intensive grazing on the indigenous grass lands. We are of the opinion that under these conditions supplementary swamp grazing would be necessary during the dry season. Before selecting an area of natural grassland to form a paddock we feel that great care should be exercised. Certain grasses which are undesirable and which increase rapidly with intensive grazing occur in patches (e.g. *Sporobolus pyramidalis*), and again certain areas would require too long to form a good pasture because of the relative proportions of the various grasses and because of the soil type. Under these conditions it would be more practical to plough and seed the pasture.

We have no information about the effect of fire on seeded pastures. It should not be forgotten, however, that fenced pastures might have to be fired at certain intervals to eliminate parasites. We hope to commence observations on this subject in the near future.

Grasses Introduced from Other Territories and Countries

A number of grasses have been introduced from time to time for trial at Serere. So far we have only had success with two introductions, viz. *Paspalum notatum* Fluegge sent from Buganda[1] and *Panicum turgidum* Forsk. from the Anglo-Egyptain Sudan. The former has done well in certain mixtures as described elsewhere in this paper. The latter, which is extremely drought resistant and which can carry on for long periods in the complete absence of rain, may prove to be of value in the more arid portions of northern Teso and Karamoja Districts. It sets seed readily and germinates well. Its habit is tufted, but not very erect, and the appearance of the plant is that of a typical xerophyte. The leaves are small and the stems, which are a bluish green, are stiff and succulent.

Amongst the introductions that have proved unsuccessful under Serere conditions (and they are the majority) are:—

Chloris gayana from Australia.[2]
Pennisetum clandestinum Hochst. (Kikuyu Grass) from Kenya.
Phleum pratense L. (Huron Timothy) from the U.S.A.
Axonopus compressus P. Beauv. from Buganda (Kampala).
Cenchrus ciliaris L. from Kenya.

The Australian *Chloris* died out after eighteen months. The Kikuyu Grass was unable to make any headway under Serere conditions; this is not surprising as the altitude is only 3,700 feet and the dry season, of three months duration, is very hot. The Huron Timothy likewise failed to stand up to Serere conditions. The *Axonopus* from Kampala was eaten off by Termites. The *Cenchrus* from Kenya, while growing well, proved to be almost completely unpalatable to cattle; this perhaps should not be included in the list of complete failures.

Grasses Found at Serere or in Vicinity

The following grasses have been collected by one of us (A.L.S.) and the identifications have been done in the Central Herbarium at Kawanda.

Andropogon schirensis Hochst.
Aristida adscensionis L. var. *guineensis* (Trin. & Rupr.) Henrard
Beckeropsis nr. *uniseta* K. Schum.
Bothriochloa glabra A. Camus
Brachiaria brizantha Stapf.
Brachiaria comata Stapf
Brachiaria decumbens Stapf
Brachiaria fulva Stapf
Brachiaria kotschyana Stapf
Brachiaria platynota (K. Schum.) Robyns.
Brachiaria soluta Stapf
Chloris gayana Kunth.
Chloris pycnothrix Trin.
Chloris virgata Swartz
Cymbopogon excavatus Stapf
Cynodon dactylon Pers.
Cynodon plectostachyum Pilg.
Ctenium concinnum Nees var. *indutum* Pilg.
Dactyloctenium aegyptum Richt.
Dichanthium papillosum (Hochst.) Stapf
Digitaria abyssinica Stapf
Digitaria ternata Stapf

[1] But originally South American.—*Ed.*

[2] But originally African.—*Ed.*

Digitaria velutina P. Beauv.
Diplachne Dummeri Stapf & Hubbard
Diplachne caudatum K. Schum.

Echinochloa pyramidalis Hitch. & Chase
Echinochloa ugandensis Snowden & Hubbard
Eleusine indica Gaertn.
Eragrostis aspera Nees.
Eragrostis chalcantha Trin.
Eragrostis cilianensis Link.
Eragrostis ciliaris Link.
Eragrostis superba Wawr. & Peyr.
Eragrostis tenuifolia Hochst.
Eragrostis tremula Hochst.
Eragrostis turgida de Wild.

Hackelochloa granularis Swartz
Harpachne Schimperi Hochst.
Hemarthria altissima Stapf & Hubbard
Heteropogon contortus P. Beauv.
Hyparrhenia cymbaria Stapf
Hyparrhenia diplandra Stapf
Hyparrhenia dissoluta (Steud.) C. E. Hubbard
Hyparrhenia filipendula Stapf
Hyparrhenia rufa Stapf
Hyparrhenia variabilis Stapf

Imperata cylindrica P. Beauv. var. *Thunbergii.* Dur. & Schinz

Leersia hexandra Swartz
Lepturus spp.
Loudetia arundinacea Steud.
Loudetia kagerensis (K. Schum.) C. E. Hubbard
Loudetia simplex (Hach. ex Engler), C. E. Hubbard
Loudetia superba De Not.

Microchloa abyssinica Hochst

Panicum atrosanguineum Hochst.
Panicum deustum Thunb.
Panicum fulgens Stapf.
Panicum infestum Stapf.
Panicum maximum Jacq.
Panicum trichocladium Hack.
Paspalum Commersonii Lam.
Pennisetum polystachyon Schult.
Pennisetum purpureum Schum.

Perotis indica O. Ktze.
Pogoanthria squarrosa Pilg.

Rhynchelytrum repens C. E. Hubbard
Rottboellia exaltata Lin. f.

Schizachyrium brevifolium Nees
Setaria kagerensis Mez.
Setaria longiseta P. Beauv.
Setaria pallidifusca Stapf & Hubbard
Setaria sphacelata Stapf & Hubbard
Setaria verticillata P. Beauv.
Setaria Chevaleri Stapf
Sorghum rigidifolium Stapf var. *microstachyum* Stapf
Sorghum verticilliflorum Stapf
Sporobolus festivus Hochst.
Sporobolus indicus R. Br.
Sporobolus pyramidalis P. Beauv.
Sporobolus Stapfianus Gand.

Themeda trianda Forsk. var. *hispida* Stapf

Urochloa panicoides P. Beauv.

COMPOST-MAKING: A NEW METHOD

This development was worked out during the last two years on the potato areas of South Lincolnshire, which have begun to suffer from shortage of humus. After the pea crop grown for canning has been harvested, the land is immediately drilled with beans. The sown area is then covered with a layer of crushed straw from the shelling machines followed by a thin layer of farmyard manure. The Indore process then sets in on the surface of the soil. The beans grow through the fermenting mass, and at the end of September are ploughed in with the layer of finished compost. Decay is rapid, and by the time the fields are planted in potatoes the following spring the resulting humus has been incorporated in the soil and is ready for nitrification. This modification is known as sheet composting—the making of humus in a thin layer all over the surface. Catch crops of beans or mustard or a crop of weeds can also be manured with humus or farmyard manure before ploughing-in in the autumn when sheet composting again takes place. The turf of old pastures or old leys can be converted into humus in a similar fashion. The Indore process has in this way been applied with success to no less than three important practical problems: green manuring, the effective utilization of weeds and stubble, and the better utilization of the old turf of grassland.

Sir Albert Howard, at the Ross Institute of Hygiene, London, quoted in *Agriculture and Livestock in India*, Vol. IX (V), p. 545, 1939.

A COMPARISON OF WATTLE GROWING IN NATAL AND IN KENYA

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PART II—KENYA CONDITIONS AND PRACTICE

1—Comparison of sites in Kenya and Natal

(*a*) *Climate*

Wattle is being grown on a considerable scale in Kenya, the main area from which bark is exported being the Central Province (including parts of the Kikuyu, Ukamba and Meru Reserves) and the European settled areas of Limuru, Kiambu and Thika.

The altitude range of the wattle area is from 4,000 feet to 8,000 feet above sea-level. The mean annual temperature ranges from 61° F. at the higher altitude to 70° F. at the lower. At the Kabete Observatory at 6,000 feet the mean annual temperature (1931–1939) is 64.1° F. The temperatures recorded for Kabete, which are here taken as average for the wattle area of Kenya, and for Cedara, which is situated in the middle of the wattle area of the Natal midlands, are compared in Table I:—

Table I

Shade Temperatures (In degrees Fahrenheit)	Kabete (1931–9)	Cedara (1931–7)
Mean Annual Maximum	73·7	73·3
Mean Annual Minimum	54·5	50·6
Mean Annual Temperature	64·1	61·9
Mean Maximum of the Hottest Month ..	78·2 (Feb.)	77·3 (Jan.)
Mean Minimum of the Coldest Month ..	51·5 (July, Aug.)	39·9 (July)

The rainfall figures for Kabete and Cedara shown alongside the mean monthly temperatures show up the marked seasonal differences between the Central Province of Kenya and the Natal midlands.

The Central Province of Kenya has two distinct rainy seasons with peak rainfalls in April and November. The midlands of Natal have a single continuous rainy season from October to March, which are the summer months when the highest temperatures are recorded. In Kenya, on the other hand, the highest temperatures are recorded in the dry season immediately preceding the April rains. In both countries, low cloud and resulting mists prevail for some months of the year, but whereas the Natal mists coincide with the warm wet summer weather, in Kenya they fall between the two rainy seasons, are not accompanied as a rule by any actual precipitation, and, by reducing insolation, produce the coldest weather of the year. Temperatures in Kenya do not, however, reach the low levels experienced in Natal, as is seen from the first table. The mean monthly minimum temperature (1931–1939) at Kabete in the coolest month of the year (July) is 51.5° F., only 9° below the mean temperature for the month. At Cedara the mean monthly minimum (1931–1937) is 39.9° F. in the coolest month of the year (July), which denotes very much colder weather than anything met with at even the highest altitudes in the Central Province.

Table II

Month	Kabete (1931–9)				Cedara (1931–7)			
	Rainfall		Temperature		Rainfall		Temperature	
	In.	Days	Monthly mean	Mean daily range	In.	Days	Monthly mean	Mean daily range
January	1·83	5	64·9	22·0	4·88	18	67·4	19·8
February	2·50	5	66·6	23·1	5·13	16	67·3	19·1
March ..	4·87	11	67·2	20·8	5·04	17	65·8	19·2
April ..	8·43	17	66·0	17·0	1·72	11	62·1	21·1
May ..	7·27	16	64·0	16·0	1·02	6	57·5	25·7
June ..	2·28	10	61·6	16·6	0·62	3	53·4	26·6
July ..	0·60	6	60·3	17·5	0·62	3	53·0	26·2
August ..	0·94	7	60·6	18·2	0·65	5	57·2	26·2
September	1·48	7	63·6	22·2	1·73	9	60·1	26·4
October..	3·09	10	65·2	21·0	3·06	15	62·1	23·9
November	4·86	17	64·9	17·2	4·34	17	63·8	21·3
December	3·55	11	64·3	18·5	5·05	20	66·2	19·9
	41·70	122	64·1	19·2	33·86	140	61·9	22·7

Table III shows the range of mean temperatures experienced month by month at Kabete and Cedara.

Table III

Month	Kabete (1931–9)			Cedara (1931–7)		
	Mean Monthly			Mean Monthly		
	Max.	Min.	Range	Max.	Min.	Range
January ..	75·9	53·9	22·0	77·3	57·5	19·8
February ..	78·2	55·1	23·1	76·9	57·8	19·1
March ..	77·6	56·8	20·8	75·4	56·2	19·2
April	74·5	57·5	17·0	72·7	51·6	21·1
May	72·0	56·0	16·0	70·4	44·7	25·7
June	69·9	53·3	16·6	66·7	40·1	26·6
July	69·1	51·6	17·5	66·1	39·9	26·2
August	69·7	51·5	18·2	70·3	44·1	26·2
September ..	74·7	52·5	22·2	73·3	46·9	26·4
October ..	75·7	54·7	21·0	74·1	50·2	23·9
November ..	73·5	56·3	17·2	74·5	53·2	21·3
December ..	73·6	55·1	18·5	76·2	56·3	19·9
Mean ..	73·7	54·5	19·2	73·3	50·6	22·7

Without knowing the range of temperatures within which (moisture conditions being favourable) growth can take place in the wattle tree, it is not possible to compare accurately growing conditions in Kenya and Natal.

From Table III it can be seen that at Cedara from May to September there is a much wider range and lower minimum temperature than anything experienced at Kabete. From Table 2 it is seen that little rain falls during this cold spell, and it seems probable that only for a very few hours each day can conditions be favourable to the growth of plant life.

In Kenya, on the other hand, high temperatures are more likely to be the limiting factor in plant growth than low temperatures. In January to March temperatures reach their maxima at Kabete as also does the range. There is generally little effective rain in these months, and it would seem probable therefore that this may be a dormant season for wattle in Kenya.

Table IV shows the mean annual rainfall at different places within the wattle areas of the Central Province of Kenya and the midlands of Natal.

TABLE IV

District	Mean Annual Rainfall	Altitude
	Inches	*Feet*
KENYA—		
Kabete (Observatory) ..	41·7	5,987
Nyeri (Tumu-Tumu) ..	42·0	5,951
Nyeri (D.C.)	37·3	6,000
Thika (Karamaini)	35·3	5,100
Limuru (Mabroukie) ..	58·7	7,700
Fort Hall (D.C.)	46·1	4,200
Embu (D.C.)	41·6	4,500
Meru (D.C.)	53·9	5,134
Machakos (D.C.)	36·9	5,400
Machakos (Kangundo) ..	42·5	5,950
NATAL—		
Cedara	33·8	3,650
Howick	33·0	3,440
New Hanover	37·6	2,590
Windy Hill Estate	39·7	2,100
Dalton	29·3	3,430
Piet Retief	35·6	4,134
Richmond	44·3	2,810
Ixopo	34·3	3,000
Harding	31·7	2,690

Although these statistics show the Central Province rainfall to be generally heavier than that in Natal it is doubtful what proportion of it is rendered ineffective by evaporation and run-off; there is probably less difference between the effective rainfalls of the two countries than the figures suggest.

(*b*) *Soils*

Much of the land on which wattle is being grown in the native reserves of the Central Province is similar to that on which coffee is being grown in the adjacent European plantations. The soil, known as Kikuyu red loam, is described as "a very deep, lava-derived, lateritic red soil, with highly suitable physical properties, more especially because of its ample aeration and its capacity for holding good reserves of water which are available to plant growth during months of drought.... Though the determination of 'available' phosphates shows that the amount present at any one time is low, this normal small amount, as it becomes depleted, is simultaneously replenished by a rapid change-over from the soil reserves of phosphates" [7]. The value for supposed available phosphates is given as .001 to .002 per cent phosphoric oxide.

Williams [2] gives a chemical analysis of a typical wattle soil from the neighbourhood of Cedara which he describes as a "reddish-brown clay loam resting on Ecca shale, but intermixed with a large proportion of decomposed material from the doleritic lava that caps all the surrounding hills." The analysis shows available phosphoric oxide at .0014 per cent.

2—SILVICULTURAL PRACTICE

(*a*) *Piling Brushwood*

The burning of brushwood after felling has been condemned in South Africa on the grounds that (1) it has resulted in marked sheet erosion when continued throughout three or four rotations; (2) the dense germination of seedlings that it produces has a stunting effect on their development prior to such time as the first spacing is possible; (3) the loss of humus leads to deterioration of the site. I believe that these considerations apply equally to Kenya, and that standard practice should include the piling of brushwood along the contours, and therefore a realignment of the wattle rows, following the direction of the brushwood piles.

(*b*) *Re-seeding*

We shall only find out by experience whether in Kenya natural re-seeding can be relied upon or whether re-sowing is necessary. It will probably be found, as in Natal, that natural re-seeding is quite satisfactory on good sites, but that on poorer sites it is more satisfactory to re-sow in order to get a uniform crop from the start.

(c) *Distance between rows*

In cases where wattle plantations are to be established without the cultivation of an agricultural crop for the first twelve months, rows should not be more than 8 feet apart or less than 6 feet; this allows the wattle roots to occupy the space between the rows (and so control weed growth) at an early date.

If, however, it is proposed to cultivate agricultural crops among the young wattles for the first year, I think wider rows must be used. This will apply more particularly in the case of intercropping between the rows of naturally re-seeded plantations; here 9-foot rows should be used and cultivation limited to a 6-foot strip between the rows, thus giving each line of wattle seedlings a width of 3 feet, within which adequate selection should be possible.

(d) *Spacing the young seedlings*

I think South African silvicultural practice needs some modification for Kenya conditions. I would recommend similar spacings in the early stages, but I would not go quite as far as they do in Natal in the drastic reduction in number of trees per acre at 7 to 10 feet in height. These open stands (250 trees per acre at 7 to 10 feet high) suffer worse from froghopper attack than those kept more dense, and on the rich soils found in Kenya there is more of a tendency to heavy branching than on the light soils of Natal.

(e) *Thinning*

South African silvicultural policy will apply equally to Kenya, viz. delayed thinning is only possible on good quality sites; on average and poor sites the trees must be spaced at an early age to their final stand. As mentioned in the last paragraph, I would not recommend a rigid adherence to the South African thinning schedule on account of damage by froghopper; but on average and poor sites I think thinning down to about 250 trees per acre should be done when the trees reach 20 to 25 feet in height. On good sites I would suggest delaying this thinning until the trees reach 40 feet; by this time the thinnings should be saleable, both wood and bark. To carry out this policy of discrimination between site qualities some assessment is necessary. This can only be done by a study of the growth of existing stands of wattle all over the wattle-growing areas and a regional classification of sites based on this survey. Within the Central Province a broad classification is possible based on altitude. Average sites will generally be found between 6,000 feet and 6,700 feet. Above this altitude yields of wood and bark will be heavier and bark quality improved. Below 6,000 feet dry years will take their toll of the trees in the plantations, yields of wood and bark will be lower, and bark quality generally poorer.

The following table shows in concise form the treatment that I would recommend for wattle plantations in the Central Province of Kenya. On the Plateau conditions are different and I do not know that part of the country well enough to lay down any definite treatment for wattle there, but I would say that it should be on the lines of that proposed here for sites below 6,700 feet in the Central Province.

TREATMENT FOR WATTLE PLANTATIONS IN THE CENTRAL PROVINCE OF KENYA

Height of Trees		Treatment		No. of stems left per acre
Sites below 6,700′	Sites above 6,700′	Using rows 7′ apart	Using rows 9′ apart	
6″	6″	Space to 4½′ apart in the row.	Space to 3½′ apart in the row.	1,380
3′	6′	Space to 9′ apart in the row by pulling up alternate trees.	Space to 7′ apart in the row by pulling up alternate trees.	690
15′	25′	Space to 18′ apart in the row by cutting alternate trees.	Space to 14′ apart in the row by cutting alternate trees.	340
25′	40′	Thin by selection, to remove one tree in every four, cutting the poorer trees and leaving the better trees.		260

(f) *Fertilizing*

Craib [1] states that in Natal fertilizing "will increase the bark and wood yield by as much as 15 to 40 per cent on most soils. Financially this represents a high rate of interest."

Williams [2] gives a chemical analysis of a typical Natal wattle soil with his suggestions as to the possible benefits to be derived from fertilizing. Craib's later experiments have confirmed Williams' suggestion that wattle would respond to fertilizing with phosphate. It is possible that the same response could be obtained from wattle in Kenya, especially on average and poor sites and on second rotation crops. This will be an important point to investigate in plantations where intercropping with maize is practised in the early stages of the wattle crop, either of the first or succeeding rotations. According to Williams a "maize crop . . . drains far more phosphoric oxide from the soil than wattles do."

(*g*) *Weeding*

The European-owned plantations in the Limuru district (6,700 to 7,700 feet) show markedly stunted growth in the first twelve months following natural re-seeding, due to the practice of allowing a dense mass of seedlings to grow to 2 or 3 feet in height before any thinning is done. As the slash from the previous crop is left lying all over the ground it would be difficult to hoe out weeds, and no attempt is made to do this; weeds are at best slashed with *pangas*, together with unwanted wattle seedlings. This does not afford any relief to root competition, and improvement is only brought about eventually by the suppression of the undergrowth by the selected wattles left uncut by the cleaning gang.

The fact that in this district the wattle trees do later regain much of their robust vigour is a tribute to the quality of the Limuru soils and climate for wattle-growing.

In the neighbouring but drier district at Kikuyu sites are not so good, and there is no doubt that unless crops are kept well weeded there will be a permanent loss of vigour to the trees. *Sangari grass* (*Digitaria abyssinica*) may be a serious factor to contend with in establishing re-seeded crops, and is a strong argument in favour of allowing intercropping by squatters between the rows of wattles for twelve months after the previous crop is felled. Even so some expense must be incurred by weeding in the lines of seedlings. Squatters may cultivate a 6-foot wide strip between two lines of seedlings 9 feet apart, but the lines themselves (3 feet) must be kept well weeded by paid labour. Four weedings will probably be necessary in the twelve months following re-seeding.

(*h*) *Pruning*

If pruning has been proved an economic success in Natal, then it must be far more so with the cheaper labour in Kenya. As I have already mentioned in Part I, pruning is not a wholesale operation; it only allows the removal of any branch which appears to be threatening to oust the leading shoot. I would suggest that in Kenya a first pruning should be done when the trees are 10 feet in height; this should therefore follow the spacing of the seedlings to 345 per acre (*see* paragraph (*d*)). The operation should normally cost about 20 cents per acre, unless there has been damage by froghopper causing a setback to the leading shoot and abnormal development of side branches.

A second pruning (still only cutting any branch which is making a fork or threatening to oust the leading shoot) should be done (by climbing the tree) when the wattles reach 25 feet in height. On average and poor sites this will be after the final thinning to 200 trees per acre. It will cost about 50 to 70 cents an acre. Both operations can be done quite cleanly with sharp *pangas*.

3—Pests and diseases

Bagworm is not a pest of any importance in Kenya. A different species from the South African one is present, but rare, and has not so far been identified. The two species of thorn tree (*Acacia karroo* and *Acacia lasiopetala*) on which the South African bagworm feeds, and which were presumably its only food supply before the introduction of the Australian wattles, are not recorded from Kenya.

Froghopper is present in Kenya, but has not yet been identified. Damage by these insects is common in some districts, but its range and life-history are not yet known. I have seen heavy infestations on wattle in the Kikuyu, Limuru and Uplands areas. As already remarked, it may be worse on plantations thinned early to a wide spacing than on plantations that have been kept denser. The common method in the Central Province (particularly in Limuru) of growing wattle in a dense, irregular stand certainly reduces the effects of damage by froghopper. Such stands, two years or so after an infestation, generally show little sign of the branchiness and deformity of stem common in open-spaced plantations after froghopper attack.

The reason is probably partly empirical. If wattles are thinned when a brood of froghoppers is on the trees the insects become concentrated on the trees which are left. This view is supported in South Africa [5]. Thinning should therefore be avoided when the insects are numerous on the young trees. This means that before a thinning is made in young wattle an examination should be made to see if the insects are present.

The other reason for froghopper causing less damage in dense than in open plantations is silvicultural. The effect on the trees of a close espacement is to correct any tendency to branching induced by froghopper attack, and to encourage a straight slender branchless pole, such as may be seen in any Limuru plantation. The tendency to crookedness or loss of the leading shoot and branchiness, due to froghopper, is therefore counteracted by the density of the stand. This certainly is sticking to the safe side of silviculture, and makes

management easy if the same treatment is given to all plantations, whether good or bad. But it must involve loss of yield, both in quantity and quality of the bark, from those plantations which escaped froghopper attack in their youth, and which might quite safely have been allowed room for maximum development.

Other diseases

Of the other diseases described by Stephens and Goldschmidt [3], gummosis and the Albert Falls disease are common in the Limuru and Kikuyu districts, and probably elsewhere. South African research has yet to solve the origins of these diseases, on which Dr. Ledeboer is now working in Natal.

4—Marketing of green bark

(*a*) Williams [2] estimates that on the average green bark loses by drying about 6 per cent of its green weight in the first day, 11 per cent in two days, and 16 per cent in three days. As green bark sold to an extract factory is usually paid for on the basis of actual weight on delivery, it is worth remembering that time lost in transport is money lost to the grower, or felling contractor.

(*b*) It was mentioned earlier in this note (Part I, Thinning) that the question at what age bark first becomes saleable will determine whether a delayed thinning is economic on good sites. If bark from four- or five-year-old trees (4 inches diameter) is not acceptable by the manufacturers, then the value of the yield from this thinning will be much reduced. It is doubtful whether in Natal the wood will be saleable except near towns where there is a demand for domestic firewood, and the thinning will only be justified economically if the bark has value. In Kenya the wood is more likely to be saleable, and in native reserves the cash return from wood alone would probably justify the thinning.

Manufacturers both in Kenya and Natal at present refuse bark that shows any marked green colour, on the grounds that it is immature and presumably therefore deficient in tannin. That this is not necessarily the case is shown by Williams [2], who found that the average percentage of tanning matter in bark from trees between the ages of three and nine does not vary a great deal. He also established that the colour of an infusion from bark of young trees is lighter than that from bark of old trees, and there can therefore be no reason for rejecting such bark on the score of having too many red units of colour. Unfortunately, Williams does not seem to have investigated the ratio of tans to non-tans in the green-coloured bark from four-year-old trees, and it is presumably this factor which is responsible for the refusal of such bark by the manufacturers, who maintain that a ratio of less than 3 to 1 renders extraction uneconomic and results in a low grade of extract.

5—Yields

Bark yields in the Limuru district are believed to be in the region of 7 to 8 tons green bark per acre in eight years on fair average sites. These are probably representative of the best yields that are being obtained in many parts of the Central Province. Such yields are about as poor as those obtained in Natal under the old methods of management, which are now being replaced by improved silviculture, resulting in enhanced yields.

From a comparison of climate, rainfall and soils in the Central Province and in Natal there is nothing to make one believe that Natal conditions are in any marked manner more favourable for the cultivation of wattle than those obtaining in the Central Province of Kenya. Temperatures may be more favourable in Natal, but soils and rainfall are probably better in Kenya. Unless Kenya conditions are less favourable all round than in Natal, the yields and quality of Kenya-grown bark should be at least equal to those in Natal. If this proves not to be the case then we must undoubtedly seek the reason for any such inferiority by examining our methods of plantation management and in existing practice with regard to the harvesting, grading and marketing of dry bark.

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REVIEWS

RELATIONSHIPS BETWEEN RAINFALL AND COFFEE YIELDS IN THE KONA DISTRICT, HAWAII, by L. A. Dean; *J. Agr. Res.*, Vol. 59, No. 3, 1939, pp. 217-222.

AN ANALYSIS OF GROWTH AND YIELD RELATIONSHIPS OF COFFEE TREES IN THE KONA DISTRICT, HAWAII, by J. H. Beaumont; *J. Agr. Res.*, Vol. 59, No. 3, 1939, pp. 223-235.

The data in these two articles are examined by a method of statistics which is perhaps unfamiliar to many readers, and a brief explanatory note is given below.[1]

The first article clearly proves that irregularity in the rainfall in the period February to June, at the time fruiting wood for the following year is being produced, adversely affects that year's yield.

The importance of the influence of meteorological conditions (including rainfall) on yield and growth of coffee has been fully realized in East Africa. The subject came up for consideration at the last meeting of the Inter-territorial Coffee Research Committee, and data are being accumulated. A period of at least twenty-five years is usually considered necessary for such studies.

The Hawaiian figures show a distribution of rainfall much superior to that of the Lyamungu area, where, although sufficient data are not available for treatment by the method used in these articles, it is noteworthy that abnormally low yields have occurred in the years in which the number of falls over three inches at a time was unusually high. It must be remembered that the "effectiveness" of the rainfall is vitally important, and this depends on many things besides total amount; for example, evaporation, temperature, wind, intensity of precipitation, soil management, and soil type.

A small criticism may perhaps be made of the attempt to demonstrate the relationship between cherry yield and rainfall. This would serve no practical purpose under East African conditions where the amounts of cherry required to give a unit quantity of clean (or parchment) coffee vary enormously from season to season, quite probably due to the same factor, rainfall.

In the second article the author reports the results from studies of yield in relation to growth. The material used was multiple-stem coffee trained by the "Agobiada" method (by bending over the original vertical) and thereafter renewing each vertical as it became necessary.

The author concludes:—

"(*a*) That certain growth responses of the tree are largely dependent upon or conditioned by the size or volume of the developing crop.

(*b*) That the volume of the crop is largely determined by the growth made in the preceding growing and crop season.

(*c*) That a dominant weather factor, such as spring rains, may disturb these relationships, but the tree will resume its normal, overlapping, two-year growth-and-bearing cycle in succeeding average years.

(*d*) That by judicious pruning and fertilization—the first of which would tend to reduce the current or immediate year's crop and both of which would tend to increase the production of vigorous fruiting wood—and perhaps by other cultural practices, such as mulching, which would tend to conserve moisture, the extreme fluctuations in annual yields may be reduced and the average yield as well as the general size and vigour of the tree may be considerably increased."

It is clear that regularity in bearing is desirable from an economic standpoint. This article is important in showing how statistical methods may be used in obtaining precise information concerning factors which influence yield and so solving at least part of the large problem termed "biennial bearing".

At Lyamungu certain exploratory work has been completed using the "correlation co-efficient" (r),[2] and on four blocks, each of about one thousand trees, there were indications of positive relationship between yield and size of tree as indicated both by area of cross-section of the stem and by volume. These results led to further recording, including increments of growth, but the figures have not yet been analysed.

It is perhaps worth recalling that regularity in yield for one block as a whole showed on analysis, in that one case at all events, that it was due to individual trees being out of step in biennial bearing. It follows that the condition of the trees may have a stronger influence on yield than pronounced seasonal factors.

From this it may be gathered that much investigation remains to be done and physiological research as well as biometry has a vital part to play in solving the complex group of problems resulting in "biennial bearing".

S.M.G.

[1] The relation between one set of variables and another is expressed by the term "regression co-efficient" (b) and indicates the ratio of the change in the number of units of the dependent variable (yield) for each unit change in the independent variable (in these articles, rainfall or growth).—S.M.G.

[2] The "correlation co-efficient" measures the *relative* effect of one variable on another whilst "regression" measures the *absolute* effect.—S.M.G.

EAST AFRICAN INSECTICIDES: "The Histology and Physiology of Rotenoids in some Papilionaceae," by R. R. Le G. Worsley, *Annals of Applied Biology*, 26, (1939), 649-683.

Tobacco was applied as an insecticide in 1746, and its active principle traced to nicotine in 1828. Pyrethrum appears to have been in use in 1828, but it was not until 1924 that the structure of its active principle was known. Derris was on the market in England thirty years ago, but it is only in recent years that derris and pyrethrum have been efficiently applied in household sprays. The application of derris as a fish poison dates from very early times, and the widespread native use of these poisons in East Africa naturally led to the initiation of research at Amani in 1934 to investigate the possibility of utilizing and growing local plants as insecticides.

The present paper is one of a series of valuable contributions that have appeared from the Amani laboratories. It deals with the distribution of the active principles of derris, the rotenoids, in the tissues of East African plants. A scientist naturally describes his work under a title and with a vocabulary that defines his results without ambiguity to his colleagues. The rather forbidding title of this paper veils from the uninitiated a thrilling piece of detective work on the exact location of the rotenoids in the multicelled structure of the plant. The unit of the plant, the cell, is very approximately a cube of .02 mm. side. With the aid of a procedure evolved by the author, the position of those cells containing rotenoids in the stems, roots, leaves, flowers, seeds and other parts of *Mundulea sericea* (a local fish poison), seven species of *Tephrosia* (commonly utilized by the Swahili as *utupa*), four species of *Derris*, and two of *Milletia* have been described. Incriminating evidence is provided by microphotographs which show how few of the cells of the plant contain rotenoids. Of all the tissues studied the seed was found most commonly to contain rotenoids, and when germination starts the number of the rotenoid-containing cells, after an initial increase, diminish as growth proceeds. The healthy well-nourished plant was found to contain less rotenoids than potassium- and nitrogen-deficient ones. An adequate supply of calcium and phosphorus, on the other hand, is needed for a good insecticide. Dr. Worsley concludes that good soil is not a necessity for the successful cultivation of derris—probably a comforting fact to many East African agriculturists. The author has also attempted to draw conclusions as to the role that rotenoids play in the plant, and suggests that while they appear to have a useful one in the seed they are waste products in the other tissues. Although many factors have been covered in the present work, no doubt there are other variations in the life-history of the plant that might affect the production of rotenoids. Work along these lines may yield new methods of cultivation, and the chemist may thus become a beneficent agent in the growing prosperity of an agricultural community. On the other hand, he may find methods for the synthetical production and replacement of these plant insecticides to the confounding of the agriculturists.

Whatever the chemist's role, it is essential, if we are to utilize his discoveries to our advantage, that we have his interpretation and advice in its application. There is a danger that in East Africa no attempt should be made to apply his work and the scientist then tends to occupy himself with problems that become more and more abstruse. This position may be compared with that of the Industrial Research Boards in England, the results of whose work have been so applied as to repay their cost many times over. It may be asked if the ability and scientific potentialities of Amani are finding the application they deserve to East African practice and if there is not a need for much closer contact between commerce, administration, agriculture and science in East Africa than exists to-day. W.D.R.

FOOD AND LIFE, U.S. Department of Agriculture Handbook for 1939, $1.50.

"Man inherits certain possibilities. How they develop depends on his environment; and the most fundamental influence in the environment is food." This simple statement, so true and yet so frequently overlooked, explains why thousands of men and women consider it worth while spending their time in the study of nutrition, and why the United States Department of Agriculture has seen fit to devote over 1100 pages to the subject. Its handbook for 1939, *Food and Life*, is possibly the best one-dollar-fifty's worth the States have yet given us, and it deserves to find a place on the shelves of everyone interested in nutrition. Be he research worker, farmer, doctor, administrator, schoolmaster, jailer, or even a dyspeptic or one of the overweight brigade seeking individual guidance, he will find within its pages a great deal of interest and value with much good advice based on sound scientific principles and devoid of any trace of faddism.

The handbook opens with a summary which in rather more than 90 pages gives the reader

a bird's-eye view of the ground covered in much greater detail in Parts I and II dealing with human and animal nutrition respectively. Although many people have contributed to this book, it is singularly free from the gaps and overlapping so common in works of composite authorship, and it presents a unified picture simple and vivid in style, interesting, instructive and stimulating.

All aspects of the subject are treated, the nutritional needs of man and beast, the mechanism of digestion, the problems of supply, environmental economic and social factors, and, what so many authors ignore, the psychological aspect and the effect of taste and feeding habits.

The section on food fads and fancies dispels many an illusion and unmercifully exposes the food-fad promoter, whose misleading statements, an insidious mixture of truth and falsehood, so successfully deceive the public. Manufacturers who unfairly exploit the magic word "vitamin" in their advertising campaigns are likely to lose any of their credulous followers who happen to read the sections on vitamin needs and the vitamin content of foods, where the true significance of these much-debated, but little understood, substances is ably discussed in simple language.

The second part of the book will probably appeal most to readers of this journal. It begins with a general survey of the nutritional cycle, the fundamental basis of all mixed farming, and then goes on to a discussion of the digestive processes of domestic animals, their requirements for maintenance, growth and reproduction. It deals with the effect of feeding on the production of meat, milk, eggs, hides, wool and fur. There is also a section on the nutrition of horses and mules, and two on dogs.

The outstanding feature of the book is that it does not merely tell people what to do; it explains the *why* and *wherefore* of nutrition as well as the *how*, and ensures the reader a definite grasp of sound principles, enabling him wherever he may be to tackle his own problems in a rational and scientific manner.

A.T.C.

WATER AND THE LAND, by J. B. Clements and P. Topham; Oxford University Press, 1940, 58 pp., 1/-.

This, the second of a series of "African Welfare" publications, is a simply written exposition of the inter-relationship of soil and water, and demonstrates clearly how these assets can most efficiently be conserved and utilized. Reference is made also to certain allied matters, such as farming systems, nutrition, hygiene and education.

The text of the book is "adapted to a standard vocabulary of 2,000 of the most frequently used English words", so that Africans with a little knowledge of this language should have no difficulty in grasping the essentials of the book.

The photographic illustrations, in particular those in connexion with soil erosion, are not as good as one would wish; and perhaps a little more space could profitably have been devoted to simple practical anti-erosion methods on arable land (e.g. contour banks, "box terraces," hedges, weed lines). These, however, are but minor criticisms of an admirable little volume which should certainly be placed in the hands of all English-speaking instructors of the African, including those of the various Agricultural, Forestry and Veterinary departments.

BEES-WAX, by W. V. Harris; Department of Agriculture, Tanganyika Territory, Pamph. No. 23; Government Printer, Dar es Salaam, 1940; 17 pp. and 4 plates, 1/-.

The importance of bees-wax in the economy of Tanganyika Territory is not usually realized. Between 1932 and 1938 production varied between 400 and 750 tons, and the value of the exports between £30,000 and £81,000; moreover, most of the wax comes from dry areas, especially *Brachystegia* ("*Miombo*") country, where there is no other cash crop. It is somewhat of a surprise also to learn that most of the production is from artificial hives—the familiar log or cylinder made of bark—the ownership of which is consequently well defined, and comparatively little of the wax is the result of honey-hunters' activities in unallocated bush. Since 7 to 15 lb. of honey go to make 1 lb. of wax, and only the youngest bees make it, the average yield per hive does not exceed 2 lb. Consequently, in a year of peak production, something like 800,000 colonies of bees must have contributed to the year's output. The author demonstrates a fairly close connexion between production and the preceding year's rainfall. Good rains give the bees a longer period of activity and hence more chance to multiply.

The author describes native methods of preparing marketable wax from the crude mass extracted from the hive, and suggests simple methods of improvement. The mere straining of the melted wax through a bag of *americani* cloth reduces the contained dirt to as little as .16 per cent. One most congenial process in small-scale production, where "the comb is well chewed by the family to complete the removal of honey," is, however, likely to remain.

MIXED OR MULTIPLE CROPPING IN NATIVE AGRICULTURAL PRACTICE

By J. K. Robertson, B.Sc. (Agric.), A.I.C.T.A., Agricultural Officer, Tanganyika Territory

(*Received for publication 6th August*, 1940)

In present-day agriculture, as it has been evolved by European practice, it is customary and in fact generally necessary to plant annual crops separately. Mechanical methods of sowing, cultivation and harvesting make this imperative. Where, however, such mechanical methods have not yet been adopted mixed cropping may be more advantageous than pure planting.

On the face of it, mixed cropping appears to be a retrograde step, since even in primitive farming the various cultural operations, and especially those of sowing and harvesting, are bound to be more tedious. Obviously the primitive farmer must have had very definite reasons not only for adopting but for continuing this apparently retrograde practice. Recent studies on this subject, however, have confirmed the soundness of mixed cropping and have provided numerous data in support of the practice.

Rotation of crops, though not now regarded as strictly indispensable in modern farming, is certainly considered advisable. Mixed cropping is the primitive farmer's method of introducing a rotation into his system of farming; in other words, a simultaneous instead of a successive rotation.

In countries of dense population and consequent land shortage mixed cropping is obviously practised from sheer necessity in order to make the fullest use of all cultivable land; in fact, areas where the system is most common are in those countries notorious for land shortage, e.g. India, China, and Japan[1]. Nicol [2] has summarized many of the types of mixed cropping found in India and elsewhere. Also, where soil and climate induce rank vegetative growth, as in the coastal belt of West Africa, the maintenance of an adequate soil cover by means of a mixture of crops helps the cultivator considerably in his unceasing struggle against weed growth; this better surface cover also causes a reduction in soil temperature, thereby encouraging soil nitrification. Publications on West African agriculture [3] [4] make frequent reference to mixed planting.

Most mixed cropping combines leguminous and non-leguminous crops, advantage being taken of the power of legumes for nitrogen fixation. Mixtures of grain crops and oil seeds form a second type, while various other types of minor importance are found, e.g. grain crop plus fibre crop. In the two latter types the advantage obtained by mixed planting is probably due to the different rooting habits of the various crops, i.e. some are shallow- and some are deep-rooted, thereby tapping different layers of the soil and using different proportions of the available plant foods. The effect is thus to exhaust the soil "at a far slower rate than would one single crop, which would use up some single constituent of the soil at a rapid rate. In fact, the group of plants growing on the soil forms a 'plant society' like the natural plant societies that grow on any piece of soil left to nature" [5]. Various writers have mentioned the beneficial effect of the roots of one species on those of another or of the substances produced by one species and made available for other species in the crop mixture. While these assumptions are probably due to the nitrogen-fixation powers of legumes, it is well known that certain non-leguminous deep-rooting plants exercise a beneficial effect on the following crop. This may be due in part to the breaking up of a hard pan by the root systems of deep-rooting plants and to the aeration of the subsoil and addition of organic matter by the subsequent decomposition of the roots. The beneficial effect of cotton on the succeeding crop is taken advantage of in rotating it with tobacco, as in the U.S.A. and Rhodesia, even although the cotton crop may be grown at a loss. Pigeon pea (*Cajanus indicus*) is well known for its beneficial effect on the following crop; this may be due in part to its property of nitrogen fixation and partly to its deep-rooting habit. Again, the restorative properties of Elephant grass (*Pennisetum purpureum*) are now becoming well known, and it is being used as a fallow crop and also to plant among or near areas of permanent crops such as coffee and tea, thus providing a supply of mulching material. In Uganda it was previously the custom to crop the land for two to three years then to fallow it for any period up to ten years. Elephant grass became the dominant species in the fallow, and after

three years a pure stand was obtained. In recent years attempts have been made to short-circuit the natural reversion of fallow lands to Elephant grass by planting it at the beginning of the fallow, thereby reducing considerably the length of the fallow period. Previously the restorative properties of Elephant grass were considered to be due to the mass of vegetative growth produced and the consequent addition of humus to the soil. Recently the view has been expressed that "the beneficial portion of the grass undoubtedly lies in the rootstock" [6].

Maize, one of the main cereals grown by native tribes in East Africa, lends itself particularly to mixed cropping. Usually a legume is interplanted in maize, and if both are planted at the same time, it is usual to choose a non-climbing legume, since a vigorous climber would smother the maize crop. Suitable legumes are kidney beans (*Phaseolus vulgaris*), erect type cowpea (*Vigna catjang*), green gram (*Phaseolus mungo*), and groundnuts (*Arachis hypogaea*). If the legume is planted when the maize is ripening a quick-growing vigorous climber is generally used, as in the case of sowing velvet bean (*Stizolobium deeringianum*) in ripening maize. The velvet bean eventually forms a dense mat of vegetation on the maize stalks and the two can be cut and used as cattle fodder. Bonavist bean (*Dolichos lablab*) and Madagascar butter bean (*Phaseolus lunatus*) can also be used in this way.

In the Tanga area of Tanganyika, maize is usually grown in conjunction with cassava; in fact, comparatively little of the maize is grown pure. The maize is planted as often as three times a year and the cassava setts interplanted as soon as the maize seedlings show above ground. The maize can be consumed from three to three-and-a-half months after planting and the cassava then left to mature. Cassava does not appear to suffer unduly from shading by the maize crop in the early stages of growth and once the maize is harvested, it can develop unhampered. The mixture is an excellent one, since an early food crop is obtained and also a drought-resistant crop as an insurance against later food shortage. The only extra labour involved in the growing of the cassava is the actual planting; no weeding costs are incurred since the maize must be weeded in any case, and after the maize is harvested the cassava soon shades the ground so effectively that little or no weeding is required. A non-climbing legume may be added to this maize–cassava mixture, according to the season of planting, e.g. cowpeas in the short rains (November–December) or kidney beans at the end of the main rains (May). Pigeon pea is also found in this mixture, and its addition is a particularly useful one since it persists after both maize and cassava have been removed and forms a useful restorative crop before the land is again brought into cultivation.

In the Handeni division of Korogwe district maize is the staple food crop and cassava was but little grown until compulsory planting was introduced following two successive years of famine. Considerable difficulty was experienced in getting natives to plant an adequate area of this crop, and even then it was found that with separate planting of the two crops not only was the maize invariably planted on the best land and cassava relegated to infertile parts but the maize crop always received priority in planting and cultivation. Even after several years of separate planting of these crops the food position was by no means satisfactory. Mixed planting of maize and cassava has now been recommended for this area, and, although it is not compulsory, already the system is catching on. There has been a marked improvement in the food position, so much so that residents have expressed the opinion that food crops and food supplies are better now than ever before.

Guinea corn (*Sorghum vulgare*) is often interplanted with maize, especially in that part of the coastal belt of Tanganyika where there is no prolonged dry spell between the short and the long rains. Both are planted as the short rains permit, in November or December; the maize is harvested at the beginning of the main rains, leaving the sorghum to develop in pure culture.

An important development of mixed cropping has recently taken place in the Lindi area of Tanganyika. Sorghum is grown together with sesame (*Sesamum indicum*), and although the system is at best a compromise it appears to be highly successful. Both are planted in December–January; the sesame is harvested after three months, leaving a pure stand of sorghum. If the sorghum is fairly widely spaced the sesame grows well, but with the usual close planting practised by natives yields are not high. Again, if rain is scarce the sesame crop is a good one, the sorghum correspondingly poor, and vice versa. The system may be regarded as an insurance against the vagaries of the weather; that it has been successful so far is amply borne out [7]:—

"The bulk of the sesame exported from the Territory is grown in the Southern Province in a

simultaneous rotation with sorghum, the most important food crop, and a record crop of 5,228 tons, valued at £53,317, was shipped. Sesame is a popular crop with native cultivators, and efforts are being made to introduce it into the Morogoro district, where it could be grown with the sorghum crop."

Cotton lends itself readily to interplanting, provided that due consideration is given to the soil and climate. Usually it is found that cotton can be grown successfully in simultaneous rotation with other crops only where the soil is fertile and the rainfall ample. In drier, less fertile parts the system generally becomes that of interplanting the cotton in a ripening crop. This is confirmed by Faulkner and Mackie [3], who state that "cotton in Southern Nigeria is almost invariably interplanted with other crops . . ."; and again "In Northern Nigeria, cotton has in the past almost invariably been grown as a sole crop, but, owing to the recent low price of cotton, some farmers are beginning to interplant their cotton in crops of *gero* or maize. These are early crops which can be harvested a few weeks after the cotton is planted. This practice may be regarded as an example of the way in which the native farmer can adapt his methods to suit economic conditions. By growing a corn crop as well as cotton on the same land, he is able to obtain a greater total return for his labour, even if he loses a little in his yield of cotton. He reduces to a minimum the cost of the labour actually expended on the cotton."

The Rufiji River in Tanganyika overflows its banks to some extent every year, and in the land thus flooded both types of interplanting are seen. On the typical *mlau* or flood lands, rice is usually planted in the short rains and harvested when the water recedes, but in recent years the depth of floodwater has been so great that many of these short-rains plantings on *mlau* land have been entirely submerged. In such areas the land is completely free of vegetative growth when the water recedes, and cotton is planted as soon as the surface soil is dry enough [8]. Cotton may be planted pure or together with maize, the latter being harvested as early as possible to permit the full development of the cotton. In parts where the floodwater remains comparatively shallow, the rice crop planted in the short rains is harvested in May and June, after the subsidence of the floodwater. As the season is by then well advanced every effort is made to plant the cotton as early as possible, and for this reason cotton seed is usually interplanted in the rice either just before harvest or immediately the crop has been gathered. No clearing or cultivation is necessary, and as often as not the rice stalks are merely divided to permit planting of the cotton. That the system is successful is amply borne out [9]:—

"The importance of cotton to the large rice-growing areas of the Rufiji Valley has already been indicated. Experiments have been carried out at Mpanganya to obtain comparative data of cash returns of rice sown as a pure crop and rice intersown with cotton; the former gave 1,639 lb. of paddy at a gross return of Sh. 149 per acre, while where cotton was planted between the rows of flowering rice the yields were 1,298 lb. of rice and 597 lb. of seed cotton, the total return from the intersown crops being Sh. 163 per acre. There is also the value of the cover effect of the cotton crop, which by leaving the land clean at the end of the season appreciably reduces the labour costs for the preparation of the land in the following year."

In choosing crops to interplant with cotton care must be taken that the cotton is not unduly shaded, since cotton is not tolerant of shade. The maize and cotton mixture appears to be successful only where soil and climate permit rapid development of the maize and its subsequent removal before the cotton crop is seriously endangered by being shaded. This interplanting of cotton and maize is common on the fertile soils of Morogoro and Kilosa, but efforts to introduce the system to other (drier) parts have not been successful.

Interplanting cotton with legumes should go far towards stabilizing the area planted to the crop, since, as it is chiefly grown pure at present, the native tends to discontinue growing cotton in periods of low prices and to resume cotton planting only when prices improve. It would also maintain a better balance between food crops and cash or export crops, especially as legumes usually form too small a part of native dietary. In Uganda it is stated [10] [11]:

"An interesting development is that experiments are tending to show that cotton interplanted with one row of groundnuts gives a considerably better cash return than cotton alone. In the event of this being confirmed by repetitions of the experiments, it would be possible to increase greatly the quantity of groundnuts grown in the Protectorate without diminishing the cotton acreage. Single rows of groundnuts are apt to go down with Mosaic disease, and two rows, although less subject to Mosaic, are apt to depress the cotton yield. Difficulties such as these would have to be overcome before the practice could be made general, but the results obtained to date indicate that this is a very promising field for further research."

Experiments in Tanganyika [12] confirm that interplanting of groundnuts in cotton depresses the yield of the latter, but that the total crop and the total cash return are invariably enhanced.

A further advantage in the mixed planting of annual crops is seen where crops have to be protected against vermin, game or insect pests. During a recent locust campaign several areas of cotton were seen that had been entirely defoliated and even the bark removed from stems and branches, indicating that the locusts had probably completed their damage entirely undisturbed. Food crops only a short distance away were but little damaged. Recently a comparatively simple method of protecting native crops from wild pig has been devised, and one that natives appear to be quite prepared to follow; nevertheless, although natives in the area in question have been accustomed to mixed planting of maize and cassava for some time, they are again reverting to pure planting of cassava, since they argue that the measures suggested would be too laborious if used on both crops! In time they may modify their views. Again, where only certain crops are liable to attack by insect pests, mixed planting may prove the difference between entire loss of a crop and only slight damage.

In soil conservation work, strip-cropping has been advocated to counter soil erosion; mixed cropping, where it can be practised, although less spectacular than strip-cropping, is possibly far more effective, especially where procumbent types form part of the plant mixture.

Mixed planting of perennial crops has been a tenet of agricultural practice in many countries for some considerable time, and little more than passing reference need be made here to local examples.

Coco-nuts form the staple permanent crop along the coastal belt of Tanganyika, and although the crop is a valuable one, owners often do no work on them other than to collect the nuts. It is well known that the removal of rank grass and weed growth has a marked beneficial effect on the palms, yet prices of copra in the last few years have prevented any development in this direction. It has always been customary to interplant young coco-nuts with food crops, but there has been a welcome tendency of late, especially among small growers, to space their palms wider than usual and to grow annual crops (chiefly cassava) between the coco-nuts, even after the palms have reached maturity. The system is an excellent one, since the cultivation given to the cassava has a beneficial effect on the coco-nut palms, and in addition a valuable food crop is obtained. Further, it has been observed that the rank grass growth in neglected coco-nut plantations catches fire readily when thoroughly dry (as in the hot season between short and long rains) and that the resultant fires often spread rapidly and over a wide area. Coco-nut palms seem to be particularly easily damaged by bush fires, and several areas of once perfectly good coco-nuts are known to have been destroyed in this way. Where even single rows of cassava are planted between coco-nuts the resultant cultivation is usually able to prevent grass fires from spreading.

Citrus is an important crop in the Muhesa area of Tanga district, but here again the owners may be described as citrus pickers rather than citrus growers. Rank grass usually grows up between the citrus trees, and bush fires cause considerable damage, as in the case of coco-nut plantations. Here, again, interplanting of annual crops and the consesquent cultivation can reduce the damage by bush fires considerably.

In Bukoba [13] [14], on the western shore of Lake Victoria, both Arabica and Robusta coffee are grown in a mixed culture with bananas, while intervening patches of land may be planted to grain or leguminous crops. The bananas provide a considerable amount of vegetation which can be used as a mulch round the coffee trees. It is noteworthy that the Bukoba soils are notoriously infertile, and that outside the banana–coffee area annual crops cannot be grown successfully without large dressings of manure or compost.

No article on mixed cropping can be concluded without passing reference to British pastures established with a mixture of grass and clover seeds. The practice of growing *mashlum*, or a mixture of peas, beans, vetches and oats, is also deserving of mention. A less familiar practice, and one that should be far more commonly followed, is that of sowing a mixture of Italian ryegrass and late flowering red clover (20 lb. of the former and 3 lb. of the latter per acre is recommended), together with cereal crops, i.e. quite apart from sowing down land to grass. The ryegrass and clover keep annual weeds in check; they provide excellent grazing for sheep in the autumn after the cereal crop has been harvested, and the green turf when ploughed under enriches the soil far more than a meagre growth of weeds and stubble. Experiments conducted on succeeding crops have indicated that this ryegrass–clover turf, when ploughed under, is equal to an application of two tons of farmyard manure per acre.

Summary

Some of the advantages of mixed or multiple cropping, as opposed to growing crops in pure culture, are enumerated. The practice is particularly suited to primitive agriculture, and although of limited value in modern mechanized farming, certain types of the system are still of importance. Perennial crops, which are not so dependent on mechanized farming, are suited to the system. Examples of mixed cropping found in East Africa are given.

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DRIED ONIONS

In a recent note (*Bull. Imp. Inst.*, 38 (3), p. 324, received December, 1940), it is mentioned that the demand for dried onions in the United Kingdom is expected to increase. One ton of the dried material represents about 10 tons of the whole fresh onions. The dried onions are shipped in the form of slices, kibbled, or as powder, and are packed in tin-lined cases of 1 cwt. or 2 cwt. each, although other forms of packing might be suitable provided there was no deterioration in quality during shipment. Before the war the material, in any of the above forms, was fetching between 65s. to 70s. per cwt., but in August, 1940, was worth about 150s. per cwt., landed London.

The method of preparing the onions is briefly as follows:—

The onions should be trimmed and peeled by hand and then cut into very thin pieces, since thick pieces dry very slowly and are apt to darken on drying. Before drying the slices may be immersed in a 5 per cent salt solution for three to five minutes, and such immersion is said to reduce the tendency of the onion to darken during drying and later in storage.

During drying the temperature should not be allowed to go beyond 140° F., since above this temperature the slices tend to darken and lose their flavour. The drying is usually done on trays in tunnel driers, although kiln driers, such as those used for copra, might be suitable for the purpose. The time required for drying is between five and ten hours, and the finished material should be dry and crisp with a moisture content between 5 and 7 per cent. The slices should be turned at intervals during the drying to hasten the process. Where it is desired to produce the powder, the slices are ground by hammer mill after drying.

Sun-drying is said to give less satisfactory results than artificial drying.

THE POSSIBILITY OF ESTABLISHING GRASS UNDER MAIZE

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(*Received for publication on* 10*th February*, 1941)

In the movement towards mixed farming, which is at present progressing in the European areas and amongst the more enlightened native cultivators of Kenya, the possibility of following the arable crop closely by the pasture ley and so obviating the necessity of reploughing and sowing the grass in the following season, assumes considerable economic importance. Furthermore, recent knowledge indicates that in the interests of soil fertility it is of advantage to avoid, whenever possible, the periods of bare fallow when roots are virtually absent and the soil is exposed.

In Kenya the most widely cultivated arable crop is maize. It has been for many years the staple food of large sections of the native population, and its cultivation in the boom years has been responsible for much land deterioration in European areas. The idea of establishing grass with the maize crop is not new, and it has been put forward from time to time since the change of outlook towards mixed farming began to gather force. However, no definite experiment has been reported hitherto, and the opinion appears to have been held fairly generally that the establishment of grass under maize is not a practical proposition.

In order to obtain definite evidence on this point, the following experiment was carried out at Kabete during 1940. Maize (Muratha variety) was sown in a strip, using the spacing which is customary when grain is required, namely 3 ft. x 1½ ft. Single seeds were planted at each set, and the rows contained 13 plants each, 1½ ft. apart. Every effort was made to produce a perfect stand of maize plants by re-sowing immediately a casualty occurred in the seedling stage and subsequently guarding the plot day and night against animals and theft. It will be seen from the table to be given later that this ideal was very nearly accomplished.

Four types of grass, which have been shown in other work to be suited to the establishment of pasture leys, were chosen for the experiment. These were the Nzoia strain of *Chloris gayana* (Rhodes grass), *Bothriochloa insculpta*, the Giant *Cynodon* sp. (Giant Star Grass), and *Brachiaria dictyoneura*. The two first mentioned were established from seed, while the other two were planted as cuttings.

The grasses were sown and planted in drills midway between the rows of maize, which were 3 ft. apart, and the drills of grass were continued outside the maize for a distance equal to the length inside the maize. Half of each grass plot was thus established under maize and half outside. The plots were separated by missing two drills, i.e. one row of maize. These intervening rows of maize were regarded as controls in each case. The grass plots were kept trimmed so that a space of 3 ft. was retained on either side of the control rows. The experiment consisted of 24 grass plots and 24 controls, half of each control containing maize alone and half being blank. Each grass type was replicated six times. The plan on page 235 shows the arrangement of the plots and controls in the strip.

The total area of the grass plots in the experiment was 864 square yards, half of which was established under maize, and 120 rows of maize were involved in the actual experimental area. In recording the yields of both maize and grass, allowance was made for the effect of plot margin in the manner described later.

The maize was sown on the 9th April and the grasses were sown and planted on the 12th, virtually at the same time as the maize.

The experiment was designed primarily to determine whether it is a practical proposition to establish grass under maize, and, as this was successfully accomplished, it was desirable to discover: (*a*) any effect of the grass upon the maize crop, and (*b*) any effect of the maize upon the various grasses. Accordingly, the results were obtained by comparing the yields derived from the maize in the grass plots with that of the controls, on the basis of average yield per plant and percentage of shelled maize, and also by comparing the yield of grass in the maize area with that of the grass outside the area, after the maize crop had been harvested.

The maize cobs were harvested on the 2nd October. The grass plots, which consisted in each case of three drills (all of stoloniferous grasses except *B. insculpta*), had been allowed to extend to the maize rows adjacent to the outside drills. Each plot was thus bounded by rows of maize, and contained two rows in the interior of the plot. These two interior rows

of maize only were used to obtain the cob samples for yield determination, and in the case of each row two plants (i.e. 3 ft.) at either end were discarded to eliminate marginal effect. After discarding the end four plants from each plot in both grass plots and controls, the cobs were harvested from 18 plants in each plot and 9 plants in each control. The whole of the maize area of the experiment was then cut short, but the roots were allowed to remain in the soil. The harvested cobs were placed in cotton bags labelled according to the plots and controls, and hung up to dry.

The air-dry samples were weighed on the 28th November, and a summary of the results obtained is given in Table I.[1]

TABLE 1

YIELDS OF MAIZE AND SHELLED PERCENTAGE FROM GRASS PLOTS AND CONTROLS

	Number of plants recorded	Average yield per plant in gms.	Shelled Maize per cent of cob
24 plots (grassed)	427	227·2	79·0
24 controls ..	215	233·7	81·1

Following the maize harvest, a clearance cut of the grass plots, both within and outside the maize area, was made on the 17th of October, with a view to comparing the yields after the onset of the November rains, when the grass would normally be in condition for grazing. The rains proved to be much below expectation, but despite this considerable growth took place, and it was possible to make yield determinations on the 16th of December.

TABLE II

YIELDS OF GRASS IN MAIZE AREA AND OUTSIDE MAIZE AREA
HIGHEST YIELD STATED AS 100

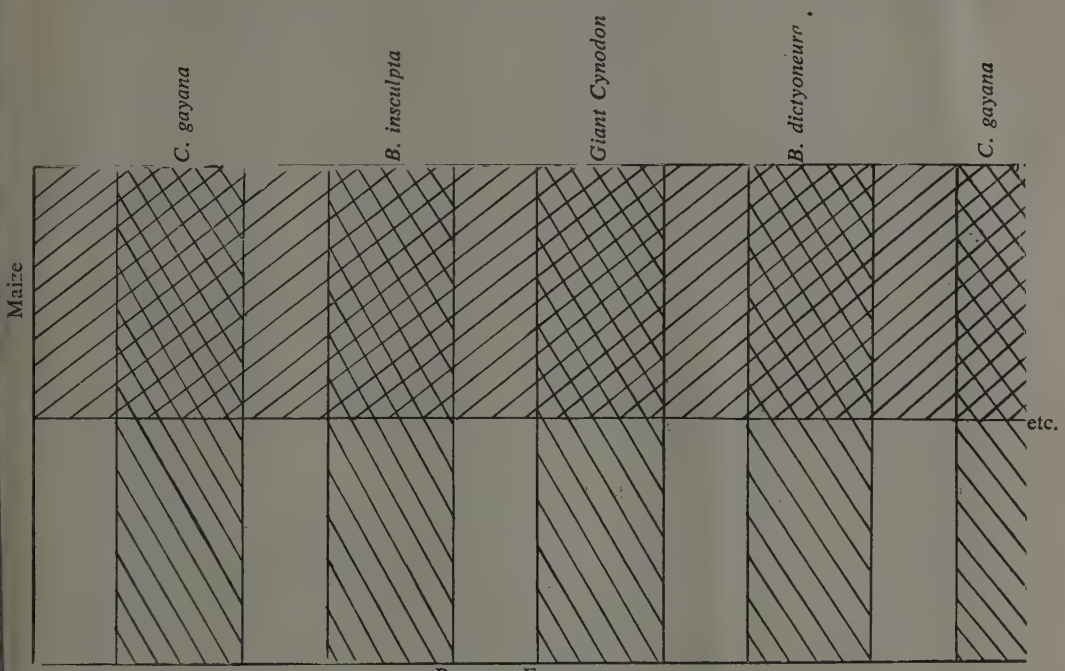
Grass	Average yield from six plots under maize	Average yield from six plots outside maize
Chloris gayana ..	75·3	100·0
Bothriochloa insculpta	37·7	52·7
Giant *Cynodon* sp. ..	64·4	74·0
Brachiaria dictyoneura	53·4	100·0

The yields were obtained by making four yard quadrat cuts within each grass plot, two in the maize area and two outside. In Table II the grass yields from the maize area in comparison with those from the non-maize area are summarized, and show the effect which the maize has had in reducing the yield of the four grass species in the first growing season after the crop.

Discussion

It will be seen from the results given above that the question whether grass can be established under maize has been answered quite definitely in the affirmative for the particular season which occurred at Kabete in the April rains of 1940. Throughout the 24 plots planted with both maize and grass, grass of one or other of the four species was successfully established. This season was rather more favourable than usual. The rains were distinctly of short duration, but for the months of April to June 24 inches of rain fell, 7.06 inches more than the average, and the short, concentrated season appeared to suit the maize crop. This is reflected in the fact that nearby plots of maize which had yielded over a period of years from 11 to 23 tons of green matter per acre, in the season under consideration gave 19.8 tons. It will therefore be appreciated that the results presented indicate that the establishment of grass under maize is feasible in a moderately good maize season, but may not hold in less favourable seasons and in drier localities. The failure of an attempt to establish Rhodes grass by undersowing maize is recorded in the Annual Report of the Agricultural Department of Northern Rhodesia for 1933, but it is stated that, in general, the crop was hindered by the early onset of dry weather and drought. It is not mentioned when the grass was sown in relation to the planting of the maize crop, although it seems evident that grass sown at the same time as the maize is much more likely to succeed than if sown later. It thus appears safe to assume that in the moister maize-growing areas of Kenya there is good prospect that the change-over from arable land to temporary grass can be accomplished more economically than has hitherto been supposed. One of the largest of these areas is the Trans Nzoia with a rainfall of 40 to 55 inches per annum (Kabete, 40 inches), where the movement towards mixed farming has already made considerable progress amongst European farmers, and maize is also important in the native agriculture of Nyanza under even higher rainfall.

[1] Tables I and II have been condensed to save space.—*Ed.*



PLAN OF EXPERIMENT

Table I suggests that both the yield and the shelled percentage of maize have been slightly affected by the grass, but the effect cannot be regarded as significant. The depression of the grass yield by the maize crop in the first season following the removal of the crop is to be expected; from the present appearance of the plots it seems that the maize and non-maize halves will become equal during the April rains, i.e. a year after the planting of the mixed crop. The important points are that all four grasses have been successfully established under the maize and that they have presented adequate material for pasturage in the November rains following the maize harvest. It is possible to deduce further from Table II that of the two heaviest yielding grasses, *Chloris gayana* and *Brachiaria dictyoneura,* the former is less adversely affected by the maize than the latter.

Apart from economic considerations which are obvious, a very important aspect of this question is believed to be that of soil fertility. In experiments at Kabete which have involved continuous cropping of plots with maize for a period of five years (ten seasons), it has been found that, despite this treatment, in a season of plentiful rainfall normal crops are still obtainable, while in seasons of deficient rainfall the effect of drought is far more marked than in the case of plots which have been recently under grass. It would appear that the chief factor involved in this effect is the deterioration of soil structure which reduces the capacity to retain moisture. It has further been shown that the complete absence of roots from a clean-weeded plot for a period of one year has gone far to produce similar results. It thus appears probable that, under the climatic conditions of Kenya, it is of peculiar importance to guard against deterioration of soil structure by avoiding as far as possible periods when plant roots are absent from the soil. In maize cultivation such periods are unavoidable, and may account in a large measure for the deleterious effects upon the soil of the continuous cultivation of this crop, or for that matter of any other clean-cultivated annual crop, but such is the importance of this consideration that attempts to overlap the maize crop with the pasture ley, and so save a season or perhaps a year of soil deterioration, appear to be worth the effort, even at the risk of possible financial loss through the occurrence of an unfavourable season.

SOME EXPERIMENTS ON STAKING DERRIS

By R. R. Le G. Worsley, A.R.C.S., B.Sc., Ph.D., Biochemist, Amani

STAKING

Derris elliptica is a creeper which sends out runners many feet in length: some plants in Amani have grown up supports to a height of over 30 feet. As usually cultivated in Malaya and other countries they have been left to creep along the ground. Preliminary trials in Amani indicated that staked plants gave a higher yield of root than unstaked ones, a result one might expect on theoretical grounds because staked plants have a greater area of leaf exposed to the light and therefore would presumably show greater growth because of increased photosynthesis.

A controlled experiment was carried out on a bed of 500 plants, in five rows of 100, spaced 2 × 1½ feet. This bed was divided into 10 plots, each of 50 plants, alternate ones being staked and unstaked. For staking, a pole about 8 feet above ground was supplied for each plant as soon as it started to produce many runners (i.e. at about one year old). All plants were dug when three years old: fine surface roots growing from recumbent stems were harvested separately. The following data were recorded for each plot:—Fresh weights of (*a*) leaves and stems, (*b*) cuttings and knobs, i.e. the original cutting and its calloused knob-like end, (*c*) surface roots, (*d*) main roots; dry weights of (*a*) cuttings, (*b*) knobs, (*c*) surface roots, (*d*) main roots. Finally the rotenone and ether extract contents of these latter four were determined.

Table 1 gives the fresh weights obtained in kilograms per plot: staked plots are S1 to S5, unstaked 1 to 5.

TABLE I

Plot	Leaves and Stems	Cuttings and Knobs	Surface Roots	Main Roots	Total
S1 ..	237·0	14·5	8·5	30·1	290·1
S2 ..	206·0	11·6	9·9	21·9	249·4
S3 ..	224·0	12·7	10·4	19·5	266·6
S4 ..	208·0	11·4	7·0	20·6	247·0
S5 ..	205·0	11·4	4·8	16·6	237·8
Total	1,080·0	61·6	40·6	108·7	1,290·9
1 ..	88·0	9·1	10·8	15·8	123·7
2 ..	84·0	8·0	8·2	14·0	114·2
3 ..	89·0	10·6	4·0	13·2	116·8
4 ..	115·0	8·6	3·1	14·2	140·9
5 ..	121·0	9·5	6·0	11·7	148·2
Total	497·0	45·8	32·1	68·9	643·8

These figures show an average total increase of 117.3 per cent in weight of leaves and stems due to staking, and in total plant weight of almost 100 per cent. It is however the yields of air-dried roots which are of economic importance, and these are shown, in kilograms per plot, in Table 2.

TABLE II

Plot	Cuttings	Knobs	Surface Roots	Main Roots
S1	5·2	1·1	2·5	13·6
S2	4·1	1·3	3·0	10·6
S3	4·0	1·1	3·0	8·9
S4	4·1	1·0	1·9	10·1
S5	4·0	1·0	2·1	7·8
Total ..	21·4	5·5	12·5	51·0
1	3·3	0·8	2·9	7·5
2	2·7	0·8	1·5	6·6
3	4·4	1·2	1·7	5·3
4	2·7	0·8	0·7	6·4
5	3·9	0·8	1·8	4·9
Total ..	17·0	4·4	8·7	30·7
Percentage Increase ..	25·9	25·0	43·7	66·1

Rotenone and ether extract determinations, calculated on an air-dry basis are shown in Table 3: with main roots determinations were made for each plot, but with the cuttings, knobs and surface roots the two bulked samples S1 to S5 and 1 to 5 were used.

TABLE III

Plot	Cuttings		Knobs		Surface Roots		Main Roots	
	Rot.	Et. Ex.	Rot.	Et. Ex.	Rot.	Et. Ex.	Rot.	Et. Ex.
	%	%	%	%	%	%	%	%
S1 ..	–	–	–	–	–	–	8·2	22·6
S2 ..	–	–	–	–	–	–	8·0	22·0
S3 ..	0·9	4·1	3·1	7·8	2·6	12·3	8·0	21·5
S4 ..	–	–	–	–	–	–	8·2	21·9
S5 ..	–	–	–	–	–	–	8·1	22·1
1 ..	–	–	–	–	–	–	8·3	21·1
2 ..	–	–	–	–	–	–	8·3	22·4
3 ..	0·9	4·0	3·2	7·9	2·6	12·4	8·2	22·0
4 ..	–	–	–	–	–	–	8·2	21·9
5 ..	–	–	–	–	–	–	8·1	22·6

Summarizing Tables 2 and 3, only the main roots are of marketable quality and the staked plots show a mean yield of 10.2 kilos of such root compared with a mean yield of 6.1 kilos for the unstaked plots, the percentage of rotenone remaining unchanged. Staking thus gave an increase of 67.2 per cent, and a statistical examination, by comparing all adjacent plots, shows this increase to be highly significant.

It is likely that under normal conditions an increase of this magnitude would more than cover the cost of staking. In practice one stake to four closely spaced plants (up to 2 × 2 feet) would probably be sufficient.

NOTES ON ANIMAL DISEASES

X—VIRUS DISEASES OF HORSES

Compiled by the Department of Veterinary Services, Kenya

Horsesickness

Horsesickness is a disease of equines caused by a filtrable ultravisible virus.

Geographical distribution.—Horsesickness occurs in the Union of South Africa, in Rhodesia, Tanganyika Territory, Kenya, Abyssinia, the Sudan and in British Somaliland. In West Africa horsesickness is said to occur in Senegal. An Arabian manuscript refers to a disease occurring in Yemen in the fourteenth century which is thought to have been horsesickness. The disease is said to occur in Southern Arabia but experimental confirmation is lacking.

Occurrence.—In Kenya it is the general experience that the appearance of the disease and its severity depend on the amount and distribution of rainfall. Heavy rains alternating with spells of hot weather and drought favour the occurrence of outbreaks.

It has long been known that horses and mules that run out day and night are more liable to contract horsesickness than those that run out only during the day. Theiler and Pitchford showed that animals housed in mosquito-proof stables are absolutely protected.

Etiology.—The causal agent is present in the blood, body fluids and organs during the temperature reaction and material filtered through Berkefeld and Chamberland candles is infective. The virus cannot be cultivated on laboratory media.

The resistance of the virus outside the body depends upon the initial virulence. Blood containing a high titre of virus may maintain its virulence for many years and putrefaction does not necessarily destroy the virus.

For preserving horsesickness virus either O.C.G. or citrate solution may be employed. Blood should be collected at the height of the temperature reaction and mixed with an equal volume of the preservative.

Susceptible Species.—Horses are the most susceptible species. Mules are slightly less susceptible, while donkeys can be infected experimentally; but rarely show anything but a mild temperature reaction. Dogs can be infected, but are very unreliable experimental subjects. Young Angora goats are also said to give a febrile reaction on inoculation. It is believed that young horses are more susceptible than old.

Nieschultz found a few years ago that mice can be infected by intracerebral inoculation. During the earlier passages only a small percentage of mice contract a fatal infection. By passage however the virus becomes adapted to the brain and a mortality of 100 per cent occurs. Alexander and du Toit found that by passage in mice the virus became attenuated for horses (when inoculated subcutaneously) and that after one hundred transfers the virus could be inoculated to horses with safety. Further work with this neurotropic variant showed that it could be used as a vaccine.

Natural Infection.—Horsesickiness is not contagious. Experience with horses stabled at night suggests that it is transmitted by some night-flying animal. So far the actual vector has not been discovered. South African workers have proved that infection will persist in three species of *Aedes* mosquitoes for several days after they have fed on infective blood; but transmission by biting has not been obtained. Similar disheartening results have attended our experiments on the transmission of Rift Valley fever by mosquitoes at Kabete and it would appear that persistence of a virus in the body of a mosquito is no evidence that that mosquito is a natural vector.

Italian workers in Abyssinia suggest that small birds that frequently perch on horses are responsible for transmitting infection. This theory is, however, quite at variance with long experience of the conditions under which infection is contracted.

Experimental transmission mechanically by *Stomoxys* was effected by Schuberg and Kuhn in 1912 but under natural conditions such cases must be very rare.

Another point in connexion with transmission that remains to be cleared up is the natural reservoir of the virus. Virus disappears fairly rapidly from the blood of a recovered animal, and from the distribution of outbreaks in Kenya, it seems possible that some animal other than an equine may be responsible for the spread and maintenance of infection. In

South Africa the disease disappears from after the first frost till late in the following summer, a period of approximately nine months.

Symptoms.—Clinically four different forms may be differentiated:—(1) The horsesickness fever; (2) The pulmonary form (Dunkop); (3) The cardiac form (Dikkop); (4) The mixed form.

Horsesickness fever is seldom diagnosed in practice in natural cases. It is the form of horsesickness in experimentally infected donkeys and Angora goats, and it is the form usually seen in horses which react to inoculation of virus after a dose of vaccine. Some horses may show slight symptoms of illness, such as disinclination to feed, increased redness of the conjunctiva, and increased respirations and pulse rate.

The incubation period varies according to the virulence of the virus and susceptibility of the animal. It averages 5 to 7 days, but shorter intervals of less than 5 days and longer ones to 15 days (rarely up to a month) may occur. The temperature may gradually rise to 105°F. or thereabouts, but is usually lower; the duration of the rise may be from one to three days, rarely longer.

The pulmonary form is characterized in its later stages by great difficulty in breathing, paroxysms of coughing and the discharge of frothy liquid from the nostrils. The onset of the symptoms is very sudden, and death usually occurs in a few hours.

The incubation period in this form varies; after inoculation it may be as short as two days or three days, more frequently it is four to five days and in exceptional cases it may be longer. In most cases fever is still present when the horse dies.

The cardiac form represents the sub-acute form of horsesickness. It is the usual form in recovered horses which contract horsesickness a second time. The incubation period averages five to seven days—rarely less, but may extend to a month; the peak is reached usually about the twelfth or thirteenth day after inoculation of virus; and by the fifteenth to seventeenth day after infection the temperature has, in cases which survive, returned to normal.

The oedematous infiltration of the tissues usually begins during the downward course of the temperature. The infiltration first occurs in the hollows of the face above the eyes, and may involve both upper and lower eyelids.

With the increase of oedematous infiltration of the tissues, distressed symptoms resembling those of the pulmonary form may develop. The onset of the disease is frequently accompanied by a dark red discoloration of the conjunctiva, and blue discoloration of the tongue (bluetongue). Some horses may show Dikkop with hardly any fever reaction.

There are two varieties of the mixed form. In the one, the pulmonary symptoms appear first, develop slowly or may even recede, to be followed by the oedematous infiltration of the cardiac form. The animal may die from either respiratory or cardiac failure.

In the other type, the disease begins with the cardiac form and is usually cut short by a paroxysm of the pulmonary form from which death occurs.

Post-mortem Lesions.—The most striking lesion in the pulmonary form of the disease is the marked oedematous infiltration of the lungs, usually accompanied by the presence of fluid in the chest cavity. In typical cases, the lungs appear distended with yellow fluid and the membrane covering the surface shows very distinct yellow venation. After being cut the lungs remain distended, although some clear liquid mixed with froth escapes from the cut surface. Oedema occurs sometimes in the membraneous tissue dividing the chest cavity and at the base of the heart sac.

The pharynx, trachea and bronchi usually contain a frothy liquid or, in rare cases, a yellowish liquid that forms a fibrinous clot may be present.

The stomach usually contains food. The fundus portion of the mucous membrane is usually diffusely red or red in patches. There may be present a patchy, reddish discoloration of the muscous membrane in the small intestine, and a diffuse reddening in the large intestine. The liver is frequently full of blood. The spleen is usually normal; but may sometimes be increased in size and its pulp may be somewhat soft.

The characteristic lesions of the cardiac form consist of a general oedematous infiltration of the subcutaneous and intramuscular tissues and, in severe cases, of the lymphatic glands.

In mild cases the head and neck are mainly affected, the striking lesions being the bulging of the hollow over the eyes. Sometimes this is accompanied by a swelling of the region of the

jaws. The swelling may extend along the neck to the skin of the shoulder and withers, and in cases of standing the infiltration may reach the region of the breast bone, the abdomen and the forearm. On cutting through the muscles of the infiltrated parts a yellow liquid is found in the connective tissue underlying the skin and the muscular tissue is moist.

The mucous membrane of the gums and tongue may be bluish-coloured (bluetongue), the intramuscular tissue of the tongue may be infiltrated and the tongue consequently swollen.

A striking lesion is the distension of the heart sac with a clear yellowish-coloured liquid which may amount to as much as a half to two litres; the outside of the heart may be diffusely brick red or patchy red around the circular and longitudinal grooves. The inside of both ventricles shows diffuse or patchy red discoloration due to extravasations of blood under the lining membrane. The heart muscle itself often contains blood extravasations.

The lungs are most frequently in a state of expiration and it is rare to find fluid in the chest cavity. The liver is, as a rule, increased in size and rich in blood. The spleen is sometimes swollen and the lesions in the intestinal canal correspond with those found in the pulmonary form of the disease.

In the mixed form both pulmonary and cardiac lesions are found together.

Immunity in Horsesickness.—Immunity in horses and mules is of a varying nature. It is well known that equines can recover from horsesickness naturally contracted. It is equally well known that animals which have gone through an attack of horsesickness, naturally or artificially contracted, and recovered, may again contract horsesickness. Further, it is the experience that some horses, which have gone through an attack of horsesickness, die from a subsequent attack of the disease, and that more deaths occur in some localities and in some seasons than in others.

Many horses which have recovered from a natural attack or from artificial inoculation will survive exposure even in the worst horsesickness localities; on the other hand, a considerable percentage of immune horses contract the disease a second time when exposed to natural infection, but observations in practice show that horses that have had one breakdown in immunity acquire a better immunity and further breakdowns are uncommon.

It is now realized that several strains of horsesickness virus exist. The antigenic composition of the virus strains is, however, not fixed. It appears liable to change on passage through horses.

Prevention.—A vaccine prepared from neurotropic variants of five strains of the virus is issued at Kabete. The actual strains employed were obtained from Onderstepoort and the vaccine issued is made by the Onderstepoort technique. The vaccine has been found to confer protection against the majority of strains of virus occurring naturally in Kenya, the Sudan and British Somaliland. Attempts are made to isolate new strains of virus from cases of horsesickness that occur in vaccinated animals with a view to their attenuation and eventual incorporation in the vaccine.

Immunity begins to develop about the third week after inoculation and immune bodies reach their maximum concentration in the serum about five months after inoculation. From the sixth month they begin to decline. Annual re-vaccination is recommended and *the time of inoculation should be chosen so that maximum protection is afforded at the time when outbreaks of the disease are most frequent.*

The vaccine is a "live" vaccine. Care should be taken that disinfectants or alcohol are not used to sterilize syringes. Syringes should be sterilized by boiling and allowed to cool properly before being filled with vaccine.

The reaction to the vaccine is so mild that it is rarely noticed even if the temperature is taken daily. Nevertheless it is recommended that horses be given light exercise only for a period of two to three weeks after inoculation. Mares in foal can be inoculated with safety.

With the increasing use of vaccine in Kenya less attention is now being paid to the old preventive measure, stabling in a mosquito-proof stable during the hours of darkness. There is no doubt, however, that stabling during darkness was of great value.

Treatment.—No method of medical treatment has been found of value. Probably more good is done by leaving a horse severely alone in a cool stable than by attempting remedial measures.

CORRESPONDENCE

P.O. Box 93, Kampala,
3rd February, 1941.

The Editor, East African Agricultural Journal.

Sir,

In the October number of the Journal, a footnote by L.R.D. appears on page 75 in conjunction with the article by Dr. Hille Ris Lambers "Impressions of the Coffee Growing in East and Central Africa," as follows:—

> "In our experience the type 'Uganda' by Java workers does not produce the pliable stems that are a feature of the 'Nganda' type, described by Thomas and well known in East Africa under that name."

While admitting that many forms of the so-called "Uganda" type during the first few years of growth produce erect and rigid main stems with primaries completely void of lateral growth, this characteristic disappears in most instances as the trees mature.

Trees under my care, grown on the multiple stem system, once the original main stem has been removed following its period of usefulness, produce a succession of fruiting growths with definite pendulous habits, arching or bending over until the growing point in many instances touches the ground. Acres of such coffee may be seen growing in Uganda.

HERBERT A. CANNON.

[Such a habit may result from (1) growing coffee under shade, and/or (2) rapid growth on fertile soil. It is not a *common* feature in native-grown "Uganda" type in either Uganda or Bukoba.—L.R.D.]

Department of Veterinary Science
and Animal Husbandry,
Mpwapwa,
Tanganyika Territory.
2nd January, 1941.

The Editor, East African Agricultural Journal.

Sir,

RICE POLISHINGS FOR CATTLE

In "The Feeding of Dairy Cows," Bulletin No. 4 of the Department of Veterinary Science and Animal Husbandry, Tanganyika Territory, I made an ambiguous statement concerning the feeding of rice polishings. Several requests have been received for the point to be more clearly stated, and I would be grateful if you could publish the following clarifying note.

The paragraph which has caused confusion reads: "The rice by-products should not be allowed to form more than 15 to 20 per cent of the total ration of milking cows because their oil contents cause butter to be soft, and also when fed in excessive amounts these by-products cause a lowering of the total food consumption."

Most farmers interpret this as stating that rice polishings should form not more than 15 to 20 per cent of the concentrate production mixture. Actually they should not form more than 20 per cent of the total of *all foodstuffs* eaten, but the quantity in the concentrate mixture can reach very much higher proportions. The maximum amounts of polishings for different types of stock are shown below:—

Breed	Live weight	Total dry matter eaten	Maximum quantity of rice polishings to be fed
Zebu	500 lb.	13 lb.	2·6 lb.
Half-grade Jersey	600 lb.	15½ lb.	3 lb.
Half-grade Ayrshire	700 lb.	17½ lb.	3·5 lb.
Half-grade Friesian	700 lb.	19¾ lb.	4 lb.

M. H. FRENCH,
Asst. Food (Animal Products) Controller.

Of all occupations by which gain is secured, there is none better than agriculture, nothing more productive, nothing more worthy of a free man.

Cicero.

There is nothing grateful but the earth; you cannot do too much for it; it will continue to repay tenfold the pains and labour bestowed upon it.

Lord Ravensworth.

GUM, RESINOUS AND MUCILAGINOUS PLANTS IN EAST AFRICA

By P. J. Greenway, Systematic Botanist, East African Agricultural Research Station, Amani

This list contains the indigenous plants yielding gums, resins and mucilages, both those of industrial and medical importance and those not yet in commerce. Exotic plants of interest in this connexion that have been established in one or more East African localities are included in brackets.

The list does not include those plants having milky or coloured exudations, such as are found in the Guttiferae (*Garcinia*), Euphorbiaceae (*Euphorbia, Manihot, Hevea*), Moraceae (*Ficus, Castilla*), Sapotaceae (*Mimusops, Payena*), Apocynaceae (*Landolphia*) and Asclepiadaceae (*Asclepias, Sarcostemma*), as they are the sources of gamboge, rubbers, chicle, balata, etc.

Scientific names of the plants and the commercial names of their products are arranged in a single alphabetical list. Unless otherwise stated all are trees or shrubs and the exudations occur on the bark of the trunk.

When available, Swahili names have been given; other African vernacular names could have been quoted, but as some species would have had as many as twenty entries they have not been included. Some of these can be obtained by consulting the books given in the classified list of references (at end of the article), such as Dale's, Eggeling's and the Uganda and Nyasaland Protectorate Check Lists, or by reference to Amani.

The country in which each is found is indicated by capital letters, i.e. U=Uganda, K=Kenya, T=Tanganyika, Z=Zanzibar and Pemba, N=Nyasaland, and NR=Northern Rhodesia. A question mark after the capital letter indicates that its occurrence in that particular country is doubtful or that it has still to be recorded in the area where one would expect to find it.

ACACIA (Tourn.) L. Mimosaceae.

Acacia Gum; Gum Arabic.

Various species of *Acacia* are the source of Acacia Gum or Gum Arabic, a dried exudation from the stems and branches. The best is obtained from *A. Senegal* (L.) Willd. (syn. *A. Verek* Guill. & Perr.) found in Kordofan and other parts of semi-arid tropical Africa. Acacia Gum is slowly soluble in cold water and has a high degree of adhesiveness and viscosity. It is used in textiles, mucilage, paste, polish, and confectionery, as a glaze in painting, as an emulsifying agent and as a demulcent in medicine.

A. albida Del.

Edible gum. Riverine forest, U, K, T, N, NR.

A. arabica Willd. *Mgunga, Mjungu,* or *Mtetewe.*

Babul, Morocco, Brown Barbary or East Indian Gum. Probably the original source of Gum Arabic but inferior to that obtained from *A. Senegal* (L.) Willd. Low-rainfall areas, K, T, N.

It is possible that the so-called *A. arabica* of East Africa should be assigned to *A. subalata* Taub.

A. Benthami Rocheb. non Meissn. *Mgunga.*

Gum recorded from South African plant; no records for the East African plant, which probably is *A. subalata* Taub.

A. campylacantha Hochst. ex A. Rich. *Mgunga* or *Mkengwa.*

Pale yellow to red-brown gum. A good adhesive, suitable for confectionery, but inferior to some other Acacia Gums. Gregarious in riverine forest. U, K, T, N, NR.

[*A. decurrens* Willd. var. *dealbata* F. Muell. and var. *mollis* Lindl.

Australian or Wattle Gum. Cultivated U, K, T, N, NR.]

A. drepanolobium Harms ex Sjostedt.

Gum. Gregarious on black cotton and volcanic soils. U, K, T.

[*A. Farnesiana* Willd.

Cassie. Amber or brown gum. Not wholly soluble in water. Cultivated U, K, T.]

A. Fischeri Harms.

Red sealing-wax-like gum. In isolated clumps in cultivated areas. T.

A. formicarum Harms.

Gum. Locally common in low-rainfall areas subject to seasonal flooding. K, T.

A. karroo Hayne.

Cape Gum. Gum could be used in confectionery, medicinal preparations, adhesives, etc. Usually riverine. N, NR.

A. Kirkii Oliv.
Gum could be used medicinally. Usually gregarious in low-rainfall areas subject to seasonal flooding. T, N, NR.

[*A. pycnantha* Benth.
Australian or Wattle Gum. Cultivated. T.]

A. Senegal (L.) Willd. (syn. *A. Verek* Guill. & Perr.). *Kikwata* or *Mgunga.*
Kordofan, Picked Turkey, White Sennar or Senegal Gum. The best Gum Arabic of present-day commerce. The trees are tapped when the fruits are ripe and the tears collected three to eight weeks afterwards. Forming thickets in low-rainfall areas. U, K, T.

A. Seyal Del. ex Oliv. and var. *fistula* Oliv. *Mgunga.*
Talha or Suakin Gum. Gum of good quality, but inferior to that of *A. Senegal*; edible when fresh. Gregarious, the var. *fistula* with galled thorns, on black cotton soil and stony ground in low-rainfall areas. U, K, T, NR.

A. Sieberiana DC. (syn. *A. nefasia* Schweinf.). *Mgunga.*
Gum clear, of good quality, very similar to that of *A. campylacantha.* In areas of well-distributed rainfall. U, K?, T, N, NR.

A. stenocarpa Hochst. ex A. Rich. (*A. Holstii* Taub.).
Suakin, Tolca or Talha Gum. One of the species affording the Gum Arabic of commerce. Locally common, but scattered in low-rainfall areas. U, K, T.

A. Stuhlmannii Taub. *Mgunga* or *Mlelawatoto.*
Gum. Very locally common on saline and black cotton soils subject to seasonal flooding. K, T.

A. xanthophloea Benth. *Mukonge.*
Fever-tree. A clear gum. A gregarious riverine tree. K, T, N, NR.

A. xiphocarpa Hochst. ex Benth. (syn. *A. abyssinica* Hochst. ex Benth.).
Believed to be a source of Aden and East India Gum. Very locally common in mountain woodland. U, K?, T.

The following are said (Malcolm, 1936) to yield a gum about which no particulars are available:—

A. etbaica Schweinf.
Gregarious in low-rainfall areas. U, K?

A. hecatophylla Steud. ex A. Rich.
Solitary or two or three together on stony hillsides. U.

A. malacocephala Harms.
Apparently gregarious in low-rainfall areas. T.

A. mellifera Benth. *Kikwata.*
Locally common in low-rainfall areas. U, K, T.

A. orfota (Forsk.) Schweinf. (syn. *A. nubica* Benth.).
Low-rainfall areas. U, K, T.

A. Rovumae Oliv.
Rare. T.

A. spirocarpa Hochst. ex A. Rich. *Mgunga, Mgunga-mwaki* or *Mkungugu.*
Locally common and frequently dominant in low-rainfall areas. U, K, T, N, NR?.

A. usambarensis Taub.
Mountain slopes and on the coast in fairly high rainfall areas. K, T, NR.

ADANSONIA L. Bombacaceae.

A. digitata L. *Mbuyu.*
Baobab Gum. A clear gum, not unlike Tragacanth, insoluble in water. Very locally common and sometimes gregarious in low-rainfall areas and on the coast. K, T, Z, N, NR.

ADEN GUM, see *Acacia xiphocarpa.*

[ADENANTHERA Royen ex. L. Mimosaceae.

A. pavonina L.
Red Sandalwood. Gum said to be exuded from the stem. Cultivated. T.]

AFRICAN BDELLIUM, see *Commophora africana.*

AFRICAN COPAIBA, see *Daniella.*

AFRICAN ELEMI, see *Canarium Schweinfurthii.*

AFRICAN KINO, see *Pterocarpus erinaceus.*

AFRICAN TRAGACANTH, see *Sterculia Tragacantha.*

AFZELIA Sm. Caesalpiniaceae.

A. africana Sm.
Said to yield a gum. Locally common and gregarious. U.

[AGATHIS Salisb. Pinaceae.
Manila Copal.
A resin of recent, semi-fossil and fossil origin; it can be hard, semi-hard or soft, and is used chiefly for interior work and enamels. Manila Copal varnishes are durable, but they do not adhere strongly to surfaces neither are they brilliant.

A. alba (Lam.) Foxw.
East Indian Dammar. Oleo-resin by natural exudation and systematic tapping, and some derived from fossil material. Introduced. T.]

ALBIZZIA Durazz. Mimosaceae.
The gums yielded by species of this genus are insoluble in water and do not

appear to be of industrial or medicinal importance.

A. amara Boiv. (syn. *A. sericocephala* Benth.).
Rare in low-rainfall areas. U, K?, T.

[*A. chinensis* Merr. (syn. *A. stipulata* Boiv.).
Cultivated. K, T, N.]

A. gummifera (Gmel.) C. A. Sm. *Mchanimbwa, Mchanimtii* or *Mkenge.*
Locally common in areas of well-distributed rainfall. U, K, T, Z, N, NR.

A. Lebbek (L.) Benth. *Mkingu* or *Msonobari.*
Doubtfully indigenous, usually planted as ornamental and avenue tree. U, K, T, Z, N, NR.

[*A. procera* (Roxb.) Benth.
Cultivated. T.]

The following are said to yield gum (Malcolm, 1936):—

A. anthelmintica (A. Rich.) Brongn. *Mporojo* or *Mtikiti.*
Locally common in low-rainfall areas. U, K, T, N, NR.

A. Harveyi Fourn. (syn. *A. hypoleuca* Oliv.).
Locally common in low-rainfall areas. K, T, N, NR.

[ALEURITES Forst. Euphorbiaceae.

A. moluccana Willd. *Mkaa.*
Candle Nut Tree. A gum or resin reported. Introduced. T, Z.]

AMERICAN COPAL, see *Hymenaea.*

AMERICAN STORAX, see *Liquidambar Styraceflua.*

ANACARDIUM L. Anacardiaceae.

A. occidentale L. *Mbibo.*
Cashew-nut Gum. A transparent gum, largely insoluble in water, and carries some of the poisonous sap. Used for bookbinding and medicinally. Locally dominant in places on the coast. K, T, Z, N, NR?.

ANGOLA COPAL, see *Copaifera Mopane.*

ANOGEISSUS Wall. Combretaceae.

Gum Ghatti, is produced by an Indian species, *A. latifolia* Wall.

A. Schimperi Hochst. ex Hutch. & Dalz.
An edible gum, semi-soluble in water, swelling to a mucilaginous mass of good viscosity and usable as a substitute for Senegal Gum. U?.

ARABIAN MYRRH, see *Commiphora abyssinica.*

[ARAUCARIA Juss. Pinaceae.

Species of this genus yield a gum-resin which runs from the trees. The gum may be of more than one kind and the resin has properties like those of Kauri Resin, *Agathis* spp. It does not appear to be of any commercial importance.

The following have been introduced into Tanganyika and probably other parts of East Africa:—

A. angustifolia (Bert.) O. Ktze. (syn. *A. brasiliana* Rich.); *A. Bidwilli* Hook., a gum-resin which contains a higher proportion of gum; *A. Cooki* R. Br.; *A. Cunninghamii* Sweet; *A. excelsa* R. Br.]

ASTRAGALUS L. Papilionaceae.

Gum Tragacanth is obtained from *A. gummifer* Lab. and several other species, natives of Asia Minor, Persia, Syria, and Greece. The gum is edible and of importance in industry and medicine. Five species have been recorded in the mountainous regions of U, K, T, N, and NR, but none of them appear to afford a gum.

AUSTRALIAN GUM, see *Acacia decurrens* and *A. pycnantha.*

[AZADIRACHTA A. Juss. Meliaceae.

A. indica A. Juss.
Neem. An amber-coloured gum used medicinally, but apparently of little commercial value. Introduced. U, T. Z.]

BABUL GUM, see *Acacia arabica.*

BALANITES Del. Simarubaceae.

Resin or gum is obtained from several species, possesses certain interesting chemical properties, but is unknown in European markets. Of the nine species recorded from East Africa, some often confused with *Balanites aegyptiaca* Del., only the following have as yet been recorded as yielding gum or resin:—

B. aegyptiaca Del. *Mchunju, Mjunju* or *Mkonge.*
Resin with a pleasant but not very strong odour. Soluble in alcohol. Locally common but scattered in low-rainfall areas. U, K, T, N?, NR.

B. Wilsoniana Dawe & Sprague. *Mkonga.*
Gum. In forest, U, K, T.

BALSAM OF MECCA, see *Commiphora.*

BALSAM OF PERU, see *Myroxylon.*

BALSAM OF TOLU, see *Myroxylon.*

BAOBAB GUM, see *Adansonia.*

BAUHINIA L. Caesalpiniaceae.

B. fassoglensis Kotschy.
Gum (Malcolm, 1936). Locally common in low-rainfall areas. U, K, T, N, NR.

B. Thonningii Schum. (syn. *B. reticulata* Oliv. non DC.). *Mchekecheke* or *Mchikichiki, Mkoma, Msabuni* and *Msegese.*
Gum, not of commercial importance. Locally common but scattered in areas of evenly distributed rainfall. U, K, T, Z, N, NR.

BDELLIUM, see *Commiphora.*

BISSABOL, see *Commiphora.*

[BOMBAX L. Bombacaceae.
B. malabaricum DC.
Gum which turns red. Not soluble in water but takes up water like Tragacanth; used medicinally in India. Introduced. T, Z, N.]

BORASSUS L. Palmae.
B. aethiopium Mart. (syn. *B. flabellifera* L. var. *aethiopium* Warb.). *Mvumo.*
Black gum which seems to be of no value. Usually gregarious under a great range of rainfall. U, K, T, Z, N, NR.

BOSWELLIA Roxb. ex Colebr. Burseraceae.
The gum-resin, Olibanum or Frankincense, is obtained from *Boswellia Carteri* Birdw. *Ubani,* native of Somaliland and Arabia, and other species. Used chiefly in incense and plasters and fumigating pastilles.
The oleo-resin, East African Elemi, is obtained from *Boswellia Frereana* Birdw., native of Somaliland, and is employed in ointment, as a stimulant and antiseptic, but is now seldom prescribed.
B. elegans Engl.
Aromatic resin. Very local in low-rainfall areas. U, K?, T.
B. Hildebrandtii Engl.
Resin. Rare. K, T?.
B. papyrifera (Del.) A. Rich.
Fragrant resin. On dry hill slopes in low-rainfall areas. U, K?.

BRACHYSTEGIA Benth. Caesalpiniaceae.
B. spiciformis Benth. (syn. *B. Randii* Bak. f.).
Deep red gum. Common and often dominant in Brachystegia woodland. T, N, NR.

BROWN BARBARY GUM, see *Acacia arabica.*

BURKEA Benth. Caesalpiniaceae.
B. africana Hook.
Semi-translucent yellow or red gum of fairly good quality. In dry woodland, not common in East Africa. U, K?, T, N, NR.

CALOPHYLLUM L. Guttiferae.
C. inophyllum L. *Mtomondo* or *Mtondoo.*
Scented gum-resin, at first a clear amber colour, but soon becoming a greenish-yellow; used medicinally in the East. Rare in places on the seashore, sometimes cultivated. K, T, Z.

CANARIUM (Rumph.) L. Burseraceae.
The genus produces two kinds of oleo-resins; some rather fragrant are called Elemi, and others which are Dammers. Manila Elemi is obtained from *Canarium luzonicum* Gray, native of the northern half of the Philippine Islands, and employed as ointment, stimulant and antiseptic, but now seldom prescribed. Industrially used in the preparation of printing inks and sometimes varnishes.
[*C. commune* L.
Oleo-resin, Elemi and a Dammar. Introduced. T.]
C. Liebertianum Engl. *Mpafu.*
Oleo-resin. Rare in coastal woodland. T.
C. Schweinfurthii Engl.
African Elemi. Oleo-resin. Not very common in evergreen rain forest and cultivated. U, K?, T, NR?.

CANNABIS (Tourn.) L. Cannabinaceae.
C. sativa L. *Mbangi.*
Indian Hemp. Soft brown resin, cannabinone, exuded by the stems and leaves, especially of the flowering branches of the female plant. Locally common, especially in abandoned native cultivations or as a weed. U, K, T, Z, N, NR.

CAPE GUM, see *Acacia karroo.*

CASHEW-NUT GUM, see *Anacardium.*

CASSIA Tourn. ex L. Caesalpiniaceae.
A number are said to yield gums which do not appear to be of commercial importance.
C. auriculata L.
Resin. Introduced, now naturalized. T.
[*C. Fistula* L.
Gum. Introduced. T, Z?.]
C. Sieberiana DC. *Mbaraka-mtoto.*
Gum. Uncommon and very local. U, K, T?.

CASSIE, see *Acacia Farnesiana.*

[CEDRELA P. Br. Meliaceae.
Gums appear to be of little value commercially.
C. odorata L.
Introduced. U, K?, T.
C. Toona Roxb. ex Rottl.
A resinous gum at one time employed in India as a febrifuge. Introduced. U, K, T, Z, N, NR.]

CEIBA Plum. ex. Mill. Bombacaceae.

C. pentandra Gaertn. (syn. *Eriodendron anfractuosum* Wr. & Arn.). *Msufi.*
Kapok. A vinous red gum only soluble when fresh; in some countries used as a remedy for dysentery. Of no commercial value. Introduced and naturalized. U, K, T, Z, N, NR.

[CERATONIA L. Caesalpiniaceae.
Tragasol Gum.

C. Siliqua L.
Carob Tree; Locust Bean. Gum present in the pods, much used in textile sizing and as a substitute for Tragacanth. Introduced. K, T, N, NR.]

CISSUS L. Ampelidaceae.

C. populnea Guill. & Perr.
Mucilage from the roots and stems. Rare. T.

[CITRUS L. Rutaceae.
A few species are recorded as yielding a gum which does not seem to be of any value. The following gum yielders are in cultivation in East Africa: *C. limetta* Risso, Lime; *C. maxima* (Burm.) Merr. (syn. *C. decumana* L.), Shaddock; *C. medica* L., Citron; *C. sinensis* Osbeck (syn. *C. aurantium* L.), Orange.]

[COCHLOSPERMUM Kunth. Cochlospermaceae.

C. gossypium DC.
Gum used as a substitute for Tragacanth and one of the sources of Kadaya Gum, used chiefly in the cigar, paste, and ice-cream industries. Introduced. K.]

[COCOS L. Palmae.

C. nucifera L. *Mnazi.*
Coco-nut. If the trunk is injured it sometimes exudes a gum which is tasteless, insoluble in water, and apparently of no value. Cultivated. K, T, Z.]

COLA Schott & Endl. Sterculiaceae.

C. cordifolia (Cav.) R. Br.
Gum. In forest, not very common. U.

COMBRETUM L. Combretaceae.
A number of West African species are of local importance on account of their gums; some have been investigated, but none appear to be in European commerce.

C. apiculatum Sond.
Dark red soluble gum. Local in dry deciduous woodland. T, N, NR.

C. Binderianum Kotschy (syn. *C. collinum* Fresen.).
U, T.

C. Frommii Gilg ex Engl.
Rare. T.

C. Guienzii Sond. subsp. *splendens* (Engl.) Exell.
Locally common in dry deciduous woodland. U, K, T, N, NR.

C. longispicatum Engl.
Locally common in low-rainfall areas. T.

C. purpureiflorum Engl.
Locally common in low-rainfall areas. T.

C. Zeyheri Sond.
Locally common and sometimes gregarious in dry deciduous woodland. T, N, NR.

COMMIPHORA Jacq. Burseraceae.
The genus is important for the species which yield resins. Myrrh is obtained from *Commiphora molmol* Engl. of Somaliland. *C. erythraea* (Ehrenb.) Engl. of Nubia yields Sweet Myrrh, Scented Bdellium or Bissabol, used in perfumes and incense. *C. Kataf* (Forsk.) Engl. of Arabia is the source of a gum-resin, Opopanax, used in perfumery and formerly of importance in medicine. *C. Myrrha* (Nees) Engl. of Southern Arabia is the source of Herabol Myrrh, a gum-resin used in medicine. *C. Opobalsamum* (Kunth.) Engl., found in Arabia and Somaliland, yields Balsam of Mecca, an oleo-resin used in incense and perfumes and of some medicinal value.

C. abyssinica (Berg) Engl.
Arabian Myrrh. Rare in low-rainfall areas. U.

C. africanum (Arn.) Engl.
African Bdellium. Rare in low-rainfall areas. U.

C. iringensis Engl.
Gum. Rare in low-rainfall areas. T.

C. ugogoensis Engl.
Gum. In low-rainfall areas. T.

CONGO COPAL, see *Copaifera.*

COPAIBA BALSAM, see *Copaifera.*

COPAIFERA L. Caesalpiniaceae.
Most of the American species of this genus yield Copaiba Balsam, a natural oleo-resin, used industrially and medicinally. The African species give a hard resin, Copal, also found semi-fossil or fossil. The most important is *Copaifera Demusei* Harms, Congo Copal; the living trees furnish some supply, but the greater part is obtained from the ground or watercourses. The resin is used industrially, especially in varnishes.

C. Mopane Kirk.
Source of Angola Copal. A hard resin, obtained from the living tree and from the ground. Gregarious, usually dominant in very dry deciduous woodland. T, N, NR.

CORDIA L. Boraginaceae.
C. Gharaf (Forsk.) Ehrenb. ex Aschers. (syn. *C. Rothii* Roem & Schultes).
Gum which is astringent and in India is used as a gargle. Locally common in low-rainfall areas. U?, K, T, N?, NR?.

CORDYLA Lour. Papilionaceae.
C. africana Lour. *Mroma, Mroo* or *Mvoo.*
A gum or resin. Very locally common, usually in riverine forest. K, T, N, NR.
C. Richardi Planch. ex Milne-Redhead.
Gum. On rocky hillsides. U.

CRATAEVA L. Capparidaceae.
C. Adansonii DC. (syn. *C. religiosa* Oliv. non Forst.).
Gum. In low-rainfall areas, not very common. U, K?, T.

[CROTON L. Euphorbiaceae.
C. tiglium L.
Croton Oil Plant. A kino. Introduced. T.]

CYCAS L. Cycadaceae.
C. circinalis L. (*C. Thouarsii* R. Br.). *Mpapindi, Mtapo* or *Mtapuu.*
Cycas Gum. A tragacanth-like gum insoluble in water but absorbing a considerable quantity and becoming a mucilage. Cultivated. K, T, Z. Wild or naturalized but very rare. T, Z.

DAMMAR, see *Canarium* and *Shorea.*

DANIELLA J. J. Benn. Caesalpiniaceae.
Various West African species yield a balsam or oleo-resin which dries to a fragrant resin known as West African Gum Copal or African Copaiba, and used as a substitute for, or adulterant of, Copaiba Balsam. Also found semi-fossilized.
D. Oliveri (Rolfe) Hutch. & Dalz.
Ilorin Balsam. Used locally as an adhesive for stopping leaks in canoes. Locally common. U.

DELONIX Rafin. Caesalpiniaceae.
D. elata (W. & A.) Gamble (syn. *Poinciana elata* L.).
Gum. In low-rainfall areas. U?, K, T, N, NR?.
[*D. regia* (Boj.) Rafin. (syn. *Poinciana regia* Boj.). *Mjohoro, Mkakaya* or *Msonobari.*
Flamboyante. Gum soluble in water and similar to Gum Arabic. Cultivated. U, K, T, Z, N, NR.]

DETARIUM Juss. Caesalpiniaceae.
D. senegalense Gmel. (syn. *D. microcarpa* Guill. & Perr.).
Fragrant resin. U?

DIALIUM L. Caesalpiniaceae.
One or two West African species yield a red gum-resin of no particular use. There are three rather rare species in East Africa, but there is no record of their yielding a gum-resin.

DICHROSTACHYS DC. Mimosaceae.
D. glomerata (Forsk.) Chiov. *Mfunga nyumba, Mkingiri, Mkulajembe, Msingino* and *Mukingiri.*
Gum. Locally common and frequently dominant in abandoned areas of native cultivation, especially in low-rainfall areas. U, K, T, Z, N, NR.

[DIPTEROCARPUS Gaertn. f. Dipterocarpaceae.
Gurjun Balsam. A genus of Indo-Malayan trees, several species of which yield an oleo-resin used as a varnish.
D. trinervis Bl.
An oleo-resin. Introduced. T.]

[DIPTERYX Schreb. Papilionaceae.
D. odorata Willd.
Tongha or Tonka Bean. A kino very like Eucalyptus Kino; a resin similar to Manila Copal in the fruit walls. Introduced. T.]

DOLICHOS L. Papilionaceae.
D. pseudopachyrhizus Harms.
The tubers and beans of this herb contain a resin which is an active fish poison. Locally common in fairly dry areas. U, K, T, N, NR.

DRACAENA Vand. Agavaceae.
Dragon's Blood. A red resin, chiefly used for colouring varnishes, is obtained from species of this genus. *D. Cinnabari* Balf. of Socotra is the source of "Zanzibar Drop" Dragon's Blood, *D. schizantha* Baker is believed to be the source of Dragon's Blood of Somaliland, and *D. Ombet* Kotschy that of Suakim.
[*D. Draco* L.
Teneriffe Dragon's Blood. Introduced. T.]

DRAGON'S BLOOD, see *Dracaena.*

EAST AFRICAN ELEMI, see *Boswellia.*

EAST INDIAN DAMMAR, see *Agathis.*

EAST INDIAN GUM, see *Acacia arabica* and *A xiphocarpa.*

ELEMI, see *Canarium.*

ENTADA Adans. Mimosaceae.

E. sudanica Schweinf. *Mgambari* or *Mnganyare.*

An inferior gum which is not used. Uncommon. U, K.

ERYTHROPHLOEUM Afz. Caesalpiniaceae.

E. africana (Welw.) Harms.

A gum like Gum Arabic. Locally common but scattered in deciduous woodland. T, N?, NR.

E. guineense G. Don. *Mbaraka, Mbaraka mkuu, Mkarati, Kkelekele, Mnienzi* and *Mwavi.*

Ordeal Tree. A gum or gum-resin. Local in areas of fairly high rainfall. U, K, T, Z, NR?

[EUCALYPTUS L'Herit. Myrtaceae.

Eucalyptus Kino; Red Gum; used medicinally. The following gum-yielding species have been introduced into East Africa: *E. amygdalina* Lab.; *E. corymbosa* Sm.; *E. marginata* Sm.; *E. rostrata* Schlecht.; *E. viminalis* Lab.]

FRANKINCENSE, see *Boswellia.*

GAMBIAN KINO, see *Pterocarpus erinaceus.*

[GREVILLEA R. Br. Proteaceae.

G. robusta A. Cunn.

Silky Oak. A vinous red gum, little soluble in water, and apparently of no commercial value. Extensively planted as a shade and windbreak. U, K, T, Z?, N, NR.]

GUM ANIMI, see *Trachylobium.*

GUM ARABIC, see *Acacia.*

GUM GHATTI, see *Anogeissus.*

GUM TRAGACANTH, see *Astragalus.*

GURJUN BALSAM, see *Dipterocarpus.*

HEERIA Meissn. Anacardiaceae.

H. insignis (Del.) O. Ktze. *Mkoko* or *Mwaolika.*

A white resin from the branches and base of the stem. Locally common in open deciduous woodland. K, T, Z, N, NR?.

HERITIERA (Dry.) Ait. Sterculiaceae.

H. littoralis Dry. ex Ait. *Mkokoshi, Mkukushu* or *Msikundazi.*

A gum or resin. Locally dominant at the mouths of streams along the coast. K, T, Z.

[HYMENAEA L. Caesalpiniaceae.

H. Courbaril L.

Para or American Copal. The stems, twigs, and even the fruits exude a large amount of resin. Fossil resin also in commerce. Used for making varnishes. Introduced. T.]

ILORIN BALSAM, see *Daniella.*

INDIAN HEMP, see *Cannabis.*

INDIAN TRAGACANTH, see *Sterculia.*

ISOBERLINIA Craib & Stapf. Caesalpiniaceae.

I. globiflora Hutch. ex Greenway (syn. *Berlinia Eminii* Taub.). *Miyombo, Myombo* or *Mwongo.*

Gum-resin of no known use. Locally common and frequently dominant in dry deciduous woodland. T, N, NR.

JATROPHA L. Euphorbiaceae.

J. Curcas L. *Mbono.*

Physic Nut. Viscid juice which turns brown and brittle when dried; of no commercial value. Naturalized, very locally common; usually planted to mark the sites of native graves. U, K, T, Z, N, NR.

KADAYA GUM, see *Cochlospermum* and *Sterculia.*

KHAYA A. Juss. Meliaceae.

The gum-resins of this genus appear to be of no use.

K. anthotheca (Welw.) C. DC.

The slash exudes a yellow gum-resin. Not very common. U.

K. grandifolia C. DC.

Gum. Riverine forest. U.

K. senegalensis (Desr.) A. Juss.

Gum semi-soluble in water and swelling to a mucilaginous mass. In riverine forest; not very common. U.

KINO.

A red astringent exudate originally derived from *Pterocarpus.* The term is now applied to similar substances from other genera.

KORDOFAN GUM, see *Acacia Senegal.*

LACQUER, see *Rhus.*

LANNEA A. Rich. Anacardiaceae.

The West African *Lannea acida* A. Rich. yields an adhesive soluble gum which is edible. The Indian *L. grandis* Engl. yields a mucilaginous gum used industrially in India.

L. Barteri (Oliv.) Engl.

Gum. Uncommon. U.

L. fruticosa (Hochst.) Engl.

Gum. Uncommon. U.

[LIQUIDAMBAR L. Hamamelidaceae.

Storax Balsam, obtained from *Liquidambar orientalis* Mill., native of south-west Asiatic Turkey, was used medicinally.

L. Styraciflua L.
American Storax or Sweet Gum. A honey-like balsam recommended as a substitute for Turkish Storax. Introduced. T.]

LOPHIRA Banks ex Gaertn. Ochnaceae.
L. alata Banks.
Gum. Uncommon. U.

MALABAR KINO, see *Pterocarpus Marsupium.*

MANGIFERA L. Anacardiaceae.
M. indica L. *Mwembe.*
Mango. A soft reddish-brown gum-resin hardening with age and slightly soluble in water. Introduced, now naturalized in many places. U, K, T, Z, N, NR.

MANILA COPAL, see *Agathis.*

[MELIA L. Meliaceae.
M. Azedarach L.
Persian Lilac. An amber-coloured or brownish gum, soluble in water but of little use. Introduced. U, K?, T, Z, N, NR?.]

MORINGA A. Juss. Moringaceae.
M. oleifera Lam. (syn. *M. pterygosperma* Gaertn.). *Mlonge, Mronge* or *Mzunze.*
Horse-radish Tree. Gum varying in colour from red, semi-opaque pink to almost white, does not dissolve in water. Used medicinally in India and Java, and can be used like Tragacanth. Usually associated with native habitations and often indicating past hut-sites. U, K, T, Z.

MOROCCO GUM, see *Acacia arabica.*

[MYROXYLON L. f. Papilionaceae.
A genus of important oleo-resin trees.
M. balsamum (L.) Harms var. *genuinum* Baill. (syn. *M. toluifera* H. B. & K.).
Balsam of Tolu. A soft, tenacious, yellowish-brown resinous mass, not soft enough to flow; used as a pleasant ingredient of cough mixtures. Introduced. T.
M. balsamum (L.) Harms var. *Pereira* (Royle) Baill. (syn. *M. Pereira* (Royle) Klotzsch).
Balsam of Peru. A liquid resembling common black treacle, used mainly as an antiseptic, internally and externally. Introduced. T.]

MYROTHAMNUS Welw. Myrothamnaceae.
M. flabellifolius Welw.
The whole plant contains an aromatic resin. Has numerous native uses, especially as a cure for bronchial diseases. Locally gregarious on stony and rocky hills. T, N, NR.

MYRRH, see *Commiphora.*

OLIBANUM, see *Boswellia.*

OPOPANAX, see *Commiphora.*

OSTRYODERRIS Dunn. Papilionaceae.
O. Stuhlmanni (Taub.) Dunn ex Bak. f. (syn. *Derris Stuhlmanni* Harms).
A kino. Scattered in deciduous woodland and in low-rainfall areas. K, T, N, NR.

PARA COPAL, see *Hymenaea.*

[PITHECELLOBIUM Mart. Mimosaceae.
P. dulce Benth.
Gum. Introduced. U, K, T, Z?.]

PSEUDOCEDRELA Harms. Meliaceae.
P. Kotschyi Harms.
A dark gum, used medicinally by natives in West Africa and as an occasional ingredient of arrow poison. U.

PSOROSPERMUM Spach. Hypericaceae.
There are about eight species of this genus in East Africa. One, *Psorospermum campestre* Engl., in Uganda exudes a dark red resin when slashed.

PTEROCARPUS L. Papilionaceae.
Kino, a red astringent substance, used medicinally. *Pterocarpus erinaceus* Poir. of West Africa is the source of African Kino or Gambian Kino.
P. angolensis DC.
A kino. Locally common in deciduous woodland. T, N, NR.
P. Bussei Harms. *Mninga, Mtumbati,* or *Muhagata.*
A kino. Doubtfully distinct from *P. angolensis* DC. Locally common in deciduous woodland. T.
[*P. indicus* Willd.
A kino. Introduced. T.]
P. lucens Guill. & Perr. (syn. *P. abyssinicus* Hochst. ex A. Rich.).
Red gum. U, N?, NR?.
[*P. Marsupium* Roxb.
Malabar Kino. Trees tapped and juice boiled down. Introduced. T.]

PYCNANTHUS Warb. Myristicaceae.
P. Kombo Warb. (syn. *Myristica angolensis* Welw.).
Statement that it produces an excellent kino doubtfully correct. Evergreen rain forest. U, K?, T.

RED GUM, see *Eucalyptus.*

RHUS (Tourn.) L. Anacardiaceae.
Lacquer. *Rhus verniciflua* DC. of China is the principal source of Lacquer.
[*R. succedanea* DC.
Japan Wax. Yields a natural varnish, obtained by tapping. Introduced. T.]

SALVADORA Garcin. ex L. Salvadoraceae.

S. persica L. *Mswaki* or *Msuaki.*
Resin used in the manufacture of varnish. Locally dominant in low-rainfall areas, especially on saline soils. U, K, T, Z?, N, NR.

[SAMANEA Merr. Mimosaceae.

S. Saman Merr. (syn. *Pithecellobium saman* (Jacq.) Benth.).
Rain Tree. An inferior gum. Introduced. U?, K, T, Z?, NR?.]

SANDARAC, see *Tetraclinis.*

SAUVAGESIA L. Ochnaceae.

S. erecta L.
Whole plant mucilaginous. An annual herb, locally common in swamps. U?, K, T, Z, N, NR.

SCHEFFLERA Forst. Araliaceae.

S. Volkensii Harms.
Gum used by some tribes for colds, coughs and lung troubles. Locally common in mountain evergreen forest. U, K, T.

[SCHINUS L. Anacardiaceae.

S. molle L.
Pepper Tree. A strong smelling resin. Introduced. U, K, T, Z?, N?, NR.]

SCLEROCARYA Hochst. Anacardiaceae.

S. Birrea (A. Rich.) Hochst.
A clear nearly colourless gum, brittle and friable when dry. Locally common in low-rainfall areas. U, K?, T, N?, NR?.

S. caffra Sond. *Mn'gongo, Mongo* or *Mungango.*
A closely related species not recorded as yielding gum. Locally common in low-rainfall areas. K?, T, Z?, N, NR.

SENEGAL GUM, see *Acacia Senegal.*

SENNAR GUM, see *Acacia Senegal.*

SESAMUM L. Pedaliaceae.
A number of species in East Africa, besides the cultivated *S. orientale* L. *Mfuta* or *Ufuta,* have mucilaginous leaves.

[SHOREA Roxb. Dipterocarpaceae.
Dammar. Obtained from South-Eastern Asian species and used chiefly in spirit varnishes and nitrocellulose lacquers, for varnishing paper, for indoor work, and histology.

S. leprosula Miq.
A resin. Introduced. T.]

SORINDEIA Thou. Anacardiaceae.
A West African species, *S. longifolia* Oliv., yields a watery resinous sap which blackens on exposure and stains black. Several species are found in East Africa, but there are no records of their yielding gum or resin.

[SPONDIAS L. Anacardiaceae.

S. cytherea Sonn. (syn. *S. dulcis* Forst.). *Mpera wa kisungu* or *Mwembe wa kizungu.*
A gum only slightly soluble in water. Introduced. T.]

STERCULIA L. Sterculiaceae.
A number of species yield a light-coloured semi-transparent Tragacanth-like gum, sometimes used in Europe for dressing fabrics. *Sterculia urens* Roxb. of India is the source of Indian Tragacanth and one of the components of Karaya Gum.

S. cinerea A. Rich. *Mbooza.*
A clear gum. In dry deciduous woodland. U, K?, T.

S. Tragacantha Lindl.
African Tragacanth. A pinkish gum like Tragacanth found in commerce as an adulterant of Gum Arabic; used industrially. On the margins of forests; rare. NR.

STORAX, see *Liquidambar.*

SUAKIM GUM, see *Acacia Seyal* and *A. stenocarpa.*

SWEET GUM, see *Liquidambar Styraciflua.*

[SWIETENIA Jacq. Meliaceae.

S. Mahogoni L.
Spanish or Cuban Mahogany. Yields in India a beautiful silvery gum in great abundance. Introduced. K, T.]

SYZYGIUM Gaertn. Myrtaceae.

S. Jambolanum DC. *Mtofaa* or *Mzambarau.*
A kino-like gum of no commercial value. Naturalized along the coast. K, T, Z.

TALHA GUM, see *Acacia Seyal* and *A. stenocarpa.*

TAMARINDUS Tourn. ex L. Caesalpiniaceae.

T. indica L. *Mkwaju.*
Tamarind. Gum of no value, insoluble in water but swelling enormously. Widespread but scattered, usually in dry areas, especially in riverine forest. U, K, T, Z, N, NR.

TERMINALIA L. Combretaceae.

T. macroptera Guill. & Perr. (*T. Dawei* Rolfe).
Gum. U.

T. Stuhlmannii Engl.
Gum. Locally common in low-rainfall areas. T. N?, NR?.

[TETRACLINIS Mast. Pinaceae.
Sandarac.
T. articulata (Vahl) Mast. (syn. *Calletris quadrivalvis* Vent.).
Resin, usually obtained in the form of small tears. Chiefly used in varnishes, and at one time in medicine. Introduced. T.]

THESPESIA Soland. ex Corr. Malvaceae.
T. populnea Soland. ex. Corr. *Mtakawa.*
A brown pitchy shining gum, little soluble, but swelling in water. Coastal, very locally common. K, T, Z.

TOLCA GUM, see *Acacia stenocarpa.*

TRACHYLOBIUM Hayne. Caesalpiniaceae.
Gum Animi; Gum Copal.
T. verrucosum Oliv. (syn. *T. Hornemannianum* Hayne). *Mnyanza, Msandarusi* or *Mtandarusi.*
Zanzibar Copal. Gum from the stems, branches and fruits, the latter being covered with resinous warts. Fossil, semi-fossil and tapped copal is exported from Mombasa, Zanzibar and Dar es Salaam, the fossil and semi-fossil fetching the higher price. Used in varnishes, especially for outdoor work. Locally common in coastal evergreen forest. K, T, and Z (fossil).

TRAGACANTH, see *Astragalus.*

TRAGASOL GUM, see *Ceratonia.*

TURKEY GUM, see *Acacia Senegal.*

VISMIA Vell. Hypericaceae.
A number of West African species yield resin; there are one or two in East Africa for which there is no information.

WARBURGIA Engl. Canellaceae.
W. ugandensis Sprague.
A resin used by natives for fixing tools in handles. Local in evergreen rain forest. U, K, T?.

WATTLE GUM, see *Acacia decurrens* and *A. pycnantha.*

WEST AFRICAN GUM COPAL, see *Daniella.*

WOODFORDIA Salisb. Lythraceae.
W. uniflora (A. Rich.) Koehme (syn. *W. floribunda* Broun & Massey non Salisb.).
The assertion that this shrub exudes a gum not unlike Tragacanth is incorrect. Very rare. U, K, T?.

ZANZIBAR COPAL, see *Trachylobium.*

ZIZIPHUS Juss. Rhamnaceae.
A number of species in India are said to yield gum; there are as yet no records for those found in East Africa.

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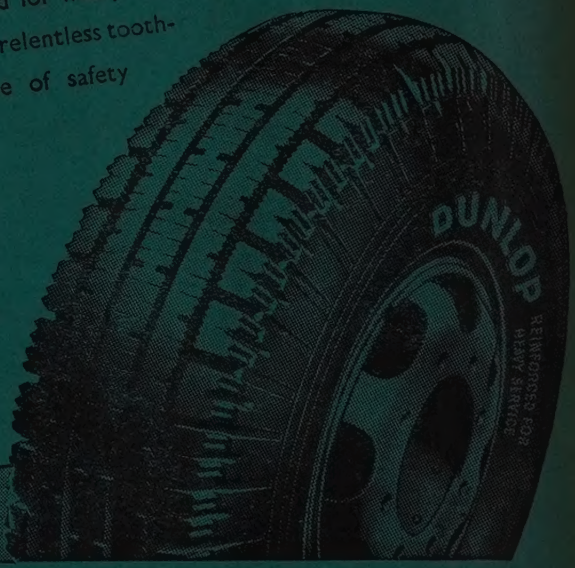

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